POWER PLANT ENGINEERING

Trade-mark reg. U. S. Pat. Office

VOL. XXIV CHICAGO, JANUARY 15, 1920 No. 2

The Handling of Cocoanut Oil

DIFFICULTIES ENCOUNTERED IN ORGANIZING THIS NEW INDUSTRY. DESCRIPTION OF THE PHILIPPINE VEGETABLE OIL CO.'S STORAGE PLANT. BY CHARLES W. GEIGER

IN ORDER properly to handle the great bulk tonnage of cocoanut oil that is now coming to various Pacific Coast ports, a number of storage plants have recently been completed and others are now under construction, embodying many new and novel features. These storage depots consist of substantially constructed steel storage tanks and pumping equipment located on shore, usually within 2000 ft. of the pier, into which the oil is discharged from the storage tanks of the steamer, through pipe lines. Such storage tanks are equipped with heating coils, and all pipe lines handling the oil are provided with heating apparatus, for in the event of a shutdown in the pumping operations the oil within a short time solidifies in the pipe line and it would not be possible to move it without the application of heat, regardless of the pressure.

The handling of this product in a hot state has required that all pipe lines be so installed that expansion strains be properly taken care of, and particular

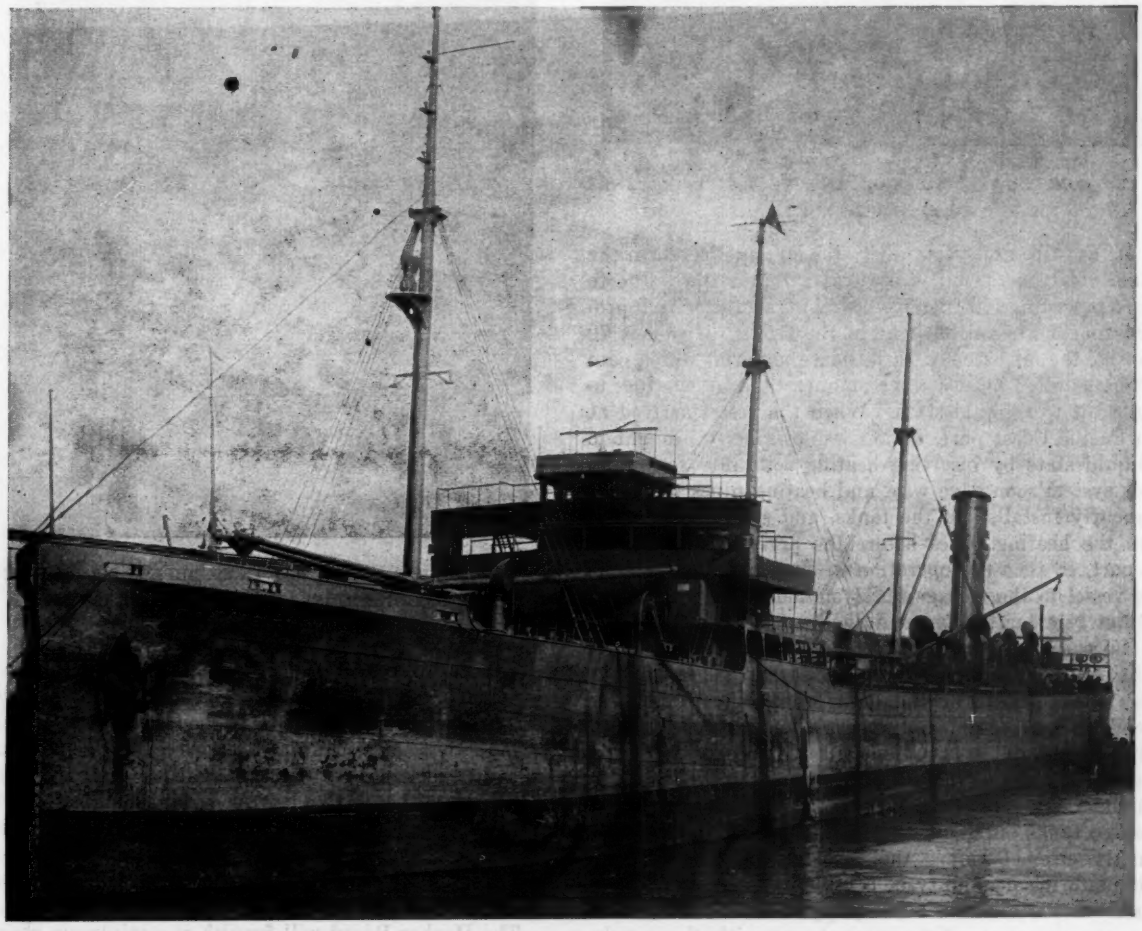


FIG. 1. TYPICAL TANK SHIP USED IN THE COCOANUT OIL TRADE

care must be exercised in the fitting up of the heating coils to insure absolute tightness at all times, for the reason that the oil when liquid being of a very penetrating nature, would find leaks, and if allowed to enter the steam coils and cool, would thoroughly plug them.

Practically all the oil received on the Pacific Coast is destined to eastern points and is transferred from storage stations to its ultimate destination in large steel tank cars of from 8000 to 10,000 gal. capacity each.

The oil in the storage tanks is made liquid and then pumped into these tank cars, the entire operation being along the same lines as for handling petroleum oils, except that on account of the nature of this oil (it becomes solid at a temperature of 70 deg. F.) the tank cars are fitted with steam heating pipes so that on arrival at the destination heat can be applied to liquefy the contents of the car and thus effect its removal.

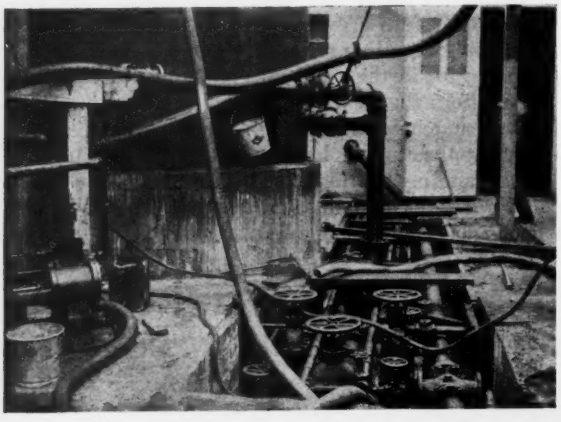


FIG. 2. CONTROL VALVES FOR OIL AND STEAM HEATING LINES TO STORAGE TANKS

At the Oriental ports where the oil is delivered to the steamer tanks, the oil is always in liquid state, due to the temperature at the tropics; but as the vessel proceeds north, the oil hardens in the tanks. At about 70 deg. F., the oil becomes hard, dense material which cannot be handled in any other manner than by heating, to restore it to a liquid state. When the vessel arrived at the Pacific Coast port, the oil was originally brought to a liquid state by inserting heating coils into the tanks. This system soon gave way, and heating pipes were permanently installed in the tanks, and steam was turned into the heating pipes before the arrival of the vessel at port, so that the operation of pumping the oil from the vessel to the storage tanks on shore could begin immediately after the vessel docked.

Cocoanut oil is now carried across the Pacific in tank ships built especially for this service, in oil tankers, in deep tanks and in special tanks of both passenger and freight steamers. The oil tankers after delivering a cargo of petroleum oil in the Orient, fill their tanks with cocoanut oil which is carried on their return trip to one of the Pacific Coast ports, where the oil is pumped into the storage tanks on shore. The tanks are, of course, thoroughly cleaned before the cocoanut oil is loaded, to eliminate the possibility of contamination. Each of the tanks on the oil tanker is equipped with heating coils, but the cocoanut oil is pumped out with the regular petroleum oil pumps. After the cocoanut oil has been delivered into the storage tanks, all traces of the cocoanut oil must also be removed from the tank steamer's tanks in order not to affect the quality of the kerosene which composes the cargo back to the Orient.

The capacity of the oil tanks on the regular passenger and freight steamers engaged in carrying cocoanut oil varies from 600 to 1200 tons. On vessels not equipped with oil pumps it is necessary to have at the Pacific ports complete portable pumping outfits, which are placed over the deep tanks of the vessels and, by means of portable suction and discharge connections, the oil is lifted out of the tanks by means of these pumps.

The first successful cocoanut oil storage station on the Pacific coast was that of Clements & Son, at Oakland, Cal. This plant was designed solely on principles arrived at from experience in the handling of the heavier asphaltum oils in cold countries, such as Vancouver, Seattle, Tacoma, etc. The second station to be erected was that of W. R. Grace & Co., San Francisco. Simultaneously with the Grace plant the Philippine Vegetable Oil Co. erected a plant at Tacoma, Wash., and later another on San Francisco Bay.

Profiting from the experiences of the various plants on San Francisco Bay, the engineers of the California State Harbor Board have designed a plant that is claimed

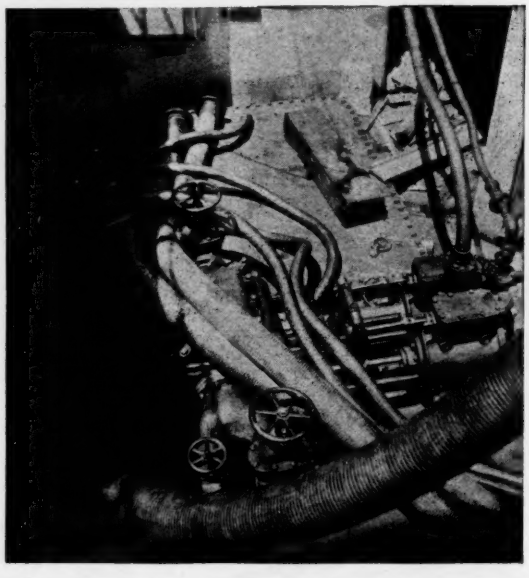


FIG. 3. PORTABLE 12 BY 10 BY 12-IN. DUPLEX OIL PUMP AND FLEXIBLE CONNECTIONS, IN POSITION OVER COCOANUT OIL TANK ON STEAMER

to embody all the desirable features of the previously constructed plants. This plant is now under construction, and when completed it is thought that it will be the most completely equipped plant on the Pacific coast, if not in the world. This plant will be located at what is known as Islais Creek. A certain number of the storage tanks will be constructed by the Harbor Board but the main plan is to rent out certain sections of space to the oil companies and let each concern install its own tankage.

The Harbor Board will furnish at a minimum charge

the piping plant, heating equipment and pumping equipment. The establishment will be known as the Oriental Vegetable Oil terminal. Large steamers will be able to unload oil directly into the plant. An oil barge has also been equipped by the Harbor Board for handling small consignments of oil from ships which could not profitably be moved from piers to the oil terminal for discharging small quantities of bulk oil.

The Philippine Vegetable Oil Co.'s Plant

As the Philippine Vegetable Oil Co.'s plant is the largest in San Francisco, a detailed description may be of interest.

The power plant is a reinforced concrete structure 25 ft. in length and about the same in width. There are two marine type water tube boilers, one 75 and the other 85 hp. The larger boiler is 13 ft. in length and the smaller 8 ft. in length. Crude oil is used as fuel, the oil being stored in a 2500-gal. tank. A mechanical spraying burner is installed in the larger boiler, operated by a direct-connected 1-hp. electric motor. In the smaller boiler, an air spraying burner is used. The air compressor is belt-driven by a 2-hp. motor, and the oil pump is chain driven from the compressor shaft. A 2-in. pipe leads from the oil tank to the oil pumps.

A pressure of 100 lb. is maintained in the 75-hp. and 150 lb. in the 85-hp. boiler. Steam is used in operating the main oil pump located in the power house and the portable pump, which is installed in vessels for pumping the oil in case a vessel is not equipped with a pump, as well as for operating small portable pumps about the plant. Steam is also used in heating the oil in the storage tanks. The oil pump in the power house is a 9 by 8¼ by 10-in. duplex. It is connected to the boilers by a 4-in. steam line. It has a capacity of from 250 to 300 tons of cocoanut oil per hour. This pump is mounted on a concrete foundation. When it is in operation it is kept throttled down to 50 lb. pressure. All steam gages are mounted on a board placed immediately above the pump. One of these gages indicates the oil pressure on the pump and another indicates the steam pressure on the pump. There is also mounted on this board a gage for indicating the steam pressure in each of the boilers, and one for the water pressure from the boiler feed pump. The boiler feed pump is 5¼ by 3½ by 5 in. The return steam pipes from the heating coils empty into a hot water tank, consisting of a submerged steel tank 6 by 6 ft. and 5 ft. in depth, surrounded by a concrete wall. This water has a temperature of 130 deg. F. and it is delivered directly by the feed water pump into the boilers, thereby eliminating a feed water heater.

The Oil Storage Tanks

The plant as originally built had eight steel storage tanks; but this has recently been increased to 14, with a capacity for further increasing the number to 19. The tanks are 43 ft. in diameter and 29 ft. in height, of substantial construction. In the construction of the tanks 7/16-in. steel was used for the bottom, ½-in. for the lower section of the sides, and 5/16-in. for the upper section of the sides. The roof is constructed of ¼-in. material. As cocoanut oil is very valuable, great precautions were taken to make the tanks as substantial and tight as possible, for cocoanut oil when in the liquid state is one of the most penetrating of liquids and will readily pass through the smallest opening. Concrete walls have been built around the storage tanks so that in case of failure of any or all of the tanks, the storage capacity within the wall would be sufficient to hold all of the oil. This provision is observed at all the vegetable oil terminals.

The storage tanks are in a double row between which run two railway tracks. A 5-in. filling line is supported at a height of 18 ft. by heavy "A" frames. This filling rack is carried between two tracks and extends for their entire length, and is connected to the main oil pump in

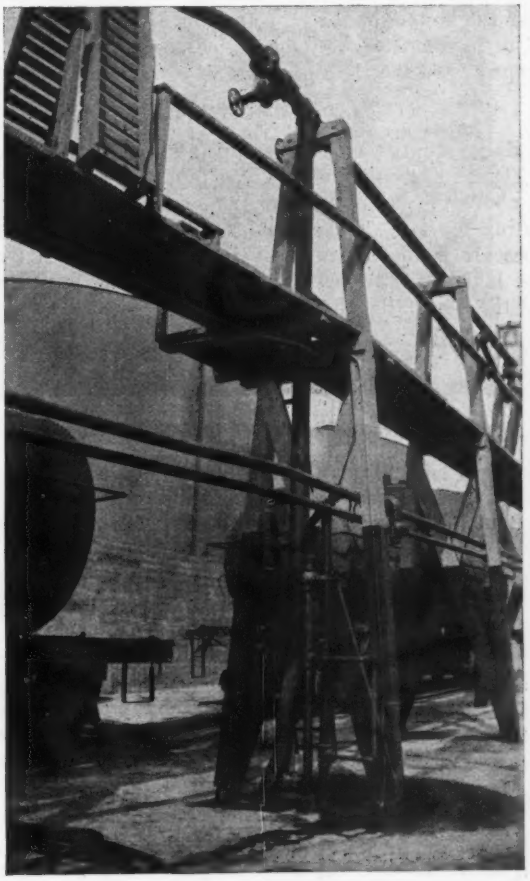


FIG. 4. RUNWAY AND SUPPORTS FOR CAR FILLING LINE AND STEAM AND WATER LINES

the power house. Between each row of storage tanks and the concrete wall that surrounds them there is a tunnel about 20 in. in width and the same depth which carries oil and steam pipes. The pipes carried in this tunnel consist of an 8-in. filling and unloading line, a 4-in. drain line, and a 2-in. steam pipe. The 8-in. filling line is connected to the main oil pump and also extends to the dock, nearly two blocks away. At the dock it is provided with a manifold. When a vessel is to discharge cocoanut oil into the storage tanks, steel flexible hose are connected with the manifold and the oil pump on board the vessel, and the oil is pumped directly into the storage tanks on shore.

The 8-in. filling line is connected to the storage tanks

about 12 in. from the bottom by means of a double elbow connection which permits the oil tank to settle in any direction without breaking the connections. Special expansion joints are placed at various points on this line to take up the expansion and contraction due to the heating and cooling.

After a cargo of oil which has been stored in the tanks for some time has been delivered into tank cars, the interior of the tank is scraped so that it will be perfectly clean for the next cargo. For the purpose of entirely draining the tank of its oil contents, a 4-in. drain line is connected to the bottom of the tank at its lowest point. There is a manhole 2 ft. square in the top of the tank, through which the cleaners can enter. Near the bottom of the tank there is a circular manhole 20 in. in diameter, through which the material that is scraped from the sides of the tank is removed.

Tank Heating Coils

Each storage tank is equipped with nearly 2000 ft. of 1½-in. heating pipes. These pipes are supported 2 in. above the bottom of the tank by 2-in. pipes. The heating pipes are laid at 10-in. centers. These heating pipes are connected to the boiler by means of a 2-in. pipe laid in the tunnel that carries the 4-in. drain line and the 8-in. filling line. When the cocoanut oil in the tanks are also located here. There is also a 2-in. steam line that extends to the dock, for supplying steam for operating the cocoanut oil pump that is installed on vessels that are not equipped with pumps. Figure 3 shows this pump as installed in a shipping board vessel. It has a capacity of pumping from 350 to 400 tons an hour. It is desirable that this pump have a great capacity, so as not to hold a vessel for unloading any longer than necessary. Connections are made between the pump and the steam line by means of flexible steel hose. Sometimes the pump is operated by steam furnished by the vessel's boilers. Flexible hose are also connected to the suction end of the pump and extended into the cocoanut oil tank. Another flexible steel hose is connected with the discharge end of the pump and the 8-in. loading pipe, after which the pumping commences. It will be noticed, in Fig. 5, that telephones are placed at various points along the storage plant. These phones are connected to a cable that extends to the dock, where it is connected to a portable telephone. This phone is taken aboard the vessel and mounted at a point near the pump. The man in charge of the pump is thus kept in direct touch with the men at the storage plant, so that the pump may be instantly shut down in case of trouble at the storage tanks.

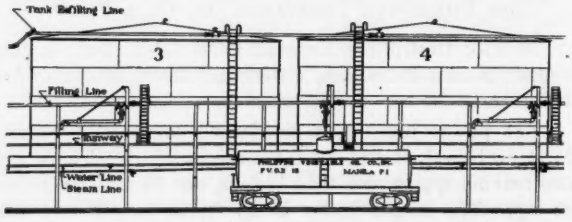


FIG. 6. ELEVATION OF TWO STORAGE TANKS, SHOWING ARRANGEMENTS FOR FILLING TANK CARS

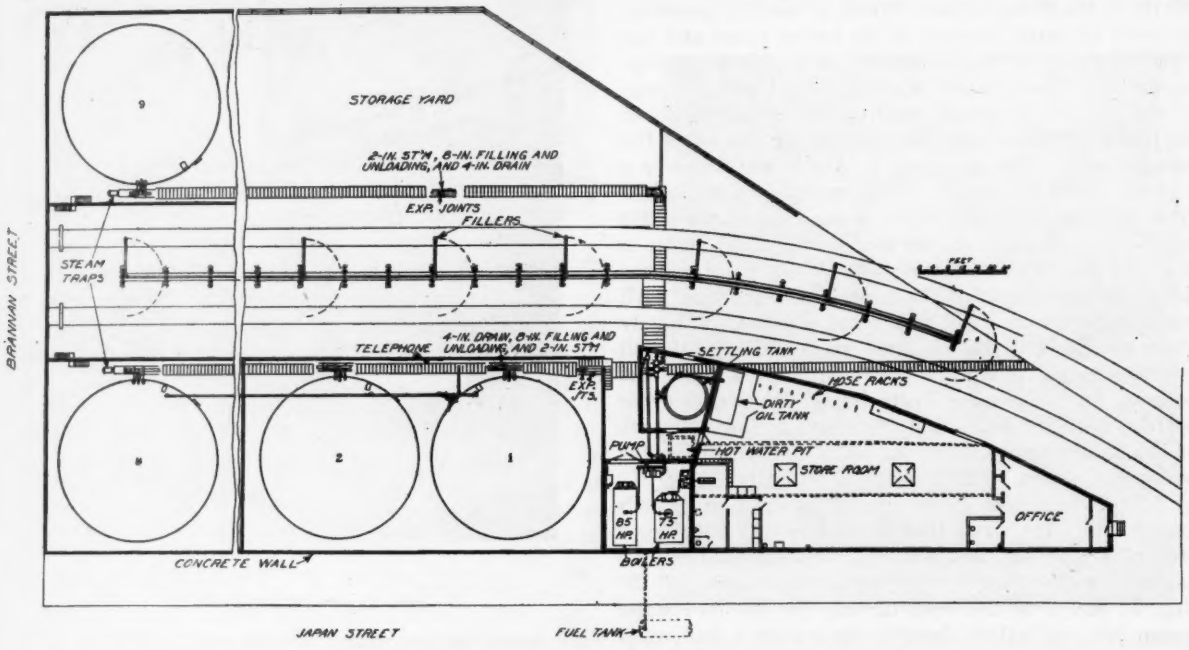


FIG. 5. PLAN OF THE PHILIPPINE VEGETABLE OIL CO.'S STORAGE PLANT

In an enlarged section of the tunnel which carries the steam and oil pipes, valves are placed so that the steam can be directed to the heating coils in each tank separately. This is shown in Fig. 2. The valves for controlling the flow of the cocoanut oil to the various tanks is to be brought to a liquid state for pumping, steam is turned into the heating coils gradually, until a pressure of 100 lb. is on. This will bring the cocoanut oil to a temperature of 110 deg. F. At this temperature the oil is in a liquid state and can easily be handled by the pumps.

Clearing the Pipe Lines

When the pump on board the steamer is shut down for any length of time, the 8-in. line leading from the dock to the storage tanks is cleared of the cocoanut oil, because if left in the pipe it will soon harden, and then it would be impossible to move it, regardless of the pressure applied. Originally this was done by forcing water through the 8-in. line; but at the present time an air compressor is being installed and the oil is forced from the pipe by introducing compressed air in the 8-in. line at the dock, which blows the line clear of all oil. This system is also used in clearing the oil lines leading from the main pump in the power house to the oil storage tanks, and also for the line leading from the pump to the filling racks which delivers the oil into the tank cars. A connection is made between the compressed air tank and the suction pipe leading from the storage tanks to the pump. This connection is made in the suction pipe near the pump, and as soon as pumping operations stop, the air is turned on, which blows all the oil from the suction pipe back into the storage tank. At the same time air is introduced into the discharge pipe and the oil remaining in the pipe leading from the pump to the car filling device is blown into the tank car.

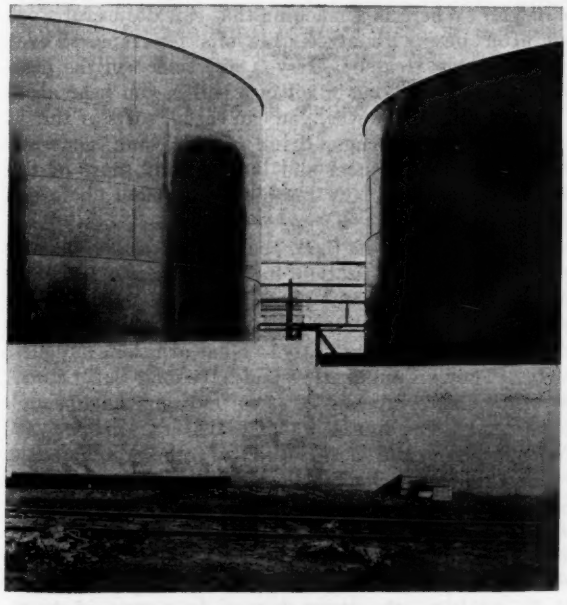


FIG. 7. SHOWING CONCRETE RETAINING WALLS AROUND STORAGE TANKS

The compressor that is being installed for this purpose is belt-driven by a 30-hp. electric motor. A 2-in. pipe leads from the compressor to the air receiver, which is 2 ft. in diameter and 10 ft. in length. A pressure of 100 lb. is maintained in the air tank.

An elaborate system has been installed for cleaning out the tank cars and for pumping the oil from the storage tanks into the tank cars. The car filling pipe line is supported at a height of 18 ft. on heavy "A" frames, as shown in Fig. 4. There are 14 filler lines connected to this line by ball bearing connections. These filler lines, by means of this ball bearing connection, can be moved in a radius of 180 deg., as shown in Fig. 5. Each filler line can serve one tank car on each side of the line. At the outer end of the filler line there is a quick shutoff valve, and a gate valve is placed in the filler line at the point where it is connected to the main car filling pipe. There is also a gate valve in the main filling pipe at a point where the filler line is connected. In filling tank cars, one man watches a number of filler lines. When the tank car is almost full, the operator closes the quick shutoff valve. He then closes the gate valve and opens the quick shutoff valve, which

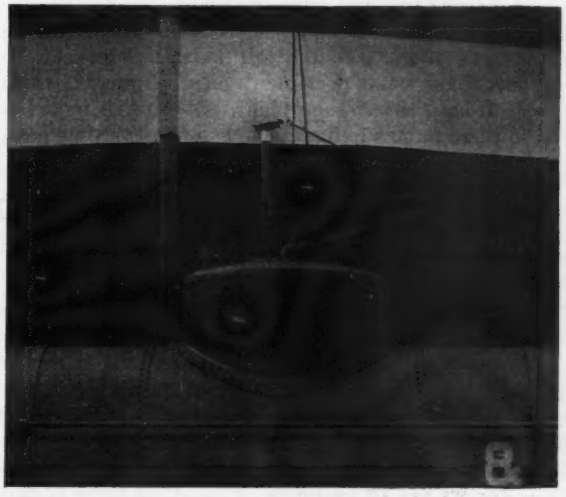


FIG. 8. ARRANGEMENT OF CAR-FILLER PIPE

permits the oil in the filler line to drain into the tank car. When pumping into all the cars ceases, the main car filling line is cleared of the oil by means of compressed air. As shown in Figs. 4 and 5, there is a passageway supported at a height of about 12 ft. by the "A" frames which enables the operators to reach the various valves along the line quickly. At each filler line there is a ladder hinged to the planks which form the passage way, which can be lowered to a horizontal position, permitting the operator to pass quickly from the passage way to the dome of the tank car, to watch the filling process. An electric light is attached to each side of each "A" frame to facilitate work at night.

All tank cars are cleaned out before being filled with the oil. For this purpose there is a 2-in. steam pipe and a 2½-in. water pipe, supported on the "A" frames. The water pipe is also used as a fire line and is connected to the city water main. By means of a special connection, shown in Fig. 4, steam can be introduced into the fire line, which both heats the water and increases the velocity of the mixture. Regular 2½-in. fire hose are connected with the fire line, and by this means the hot water is directed against the interior of the tank car with great force, which thoroughly cleans the tank, the water running out of the bottom of the tank car. Sometimes a tank car is so dirty that it is necessary to turn a head of live steam into it for a few hours, which loosens up any solid matter that may have accumulated on the inside. This is accomplished by connecting a flexible steel hose to the steam line and running it into the tank car through the dome.

Cleaning Dirty Oil

Figures 2 and 5 show a settling tank which is used

for separating cocoanut oil from water or other liquids. The mixture is pumped into this tank and permitted to settle, the water settling to the bottom of the tank, the good oil being pumped off by means of a hose introduced through the top of the tank. After the good oil has been pumped out, the water or other mixture is run off through a valve in the bottom of the tank. Figure 2 also shows the various valves for controlling the oil and steam in the various pipes, and the tunnel in which the pipes are carried. This tunnel is lined with redwood planks, 2 by 12 in. The same size planks are placed over the top of the tunnel and permit ready access to the pipes at all times. To the left in this photo can be seen one of the small portable duplex oil pumps, which is used around the storage plant. Steam can be delivered to these pumps by means of 1-in. steel flexible hose, also shown in the photo. The power plant can be seen in the background; also the oil pipe leading from the oil pump to the car filling pipes. In Fig. 5 can be seen a dirty oil tank, just to the right of the settling tank. This tank is open at the top and is equipped with heating pipes. Dirty oil is placed in this tank, usually oil that is scraped from the sides and bottom of the oil tank aboard the steamers. After being brought to a liquid state, the dirt settles to the bottom of the tank, and the clear oil is pumped off. A number of hose racks are shown where the steel flexible hose connections are carried. There is also a change room and a shower room, where the workmen may change clothes and take a shower before leaving the plant.

Figure 7 shows the retaining walls placed around the storage tanks.

Efficient Organization of Power Plant Help---I

BUILD YOUR ORGANIZATION WITH THE MOST EFFICIENT ORGANIZATION—THE HUMAN BODY—AS A MODEL. BY H. A. WILCOX

THE TITLE of this article speaks for itself, and an elaborate introduction may be considered unnecessary. Before plunging into the concrete aspects of our subject, let us first define clearly exactly what is meant by the term "efficient organization." Then let us consider an abstract example of an efficient organization and proceed to copy or imitate it as closely as possible; for we are all imitators at heart, as there is only one Creator.

This article is not a sermon, but is simply the writer's convictions, based upon his experience, and he expects that many of his readers will find flaws in his statement and disagree with him. In spite of this, however, he is going to speak right out in meeting and say, "Them's my sentiments. What's your'n?"

First then, what is an efficient organization? Look up the two words in a dictionary and combine their definitions and you have a result something like this: Various parts or components so arranged in a unit as to produce *useful* work or activity. The word *useful* is the whole meat of the matter. On a certain job, a hod-carrier may show great activity and work hard, if he carries an empty hod up and down a ladder all day long, but he is not efficient. To be sure, he may carry up a few bricks and so escape being fired, but still he is not efficient. Why? Because he is setting a bad example for the other hod-carriers and forces his boss to hire more men to get the bricks up or keeps the masons waiting. Now if this same man carries all the bricks he can, without undue fatigue, on each trip, he is doing *useful* work, as he is providing the masons with material for building. His boss will see that there are enough hod-carriers on duty to keep the masons going when each hod is full of bricks. Try to remember whether you have ever seen a gang digging a ditch. Some of the men throw a full shovel each time and others only half a shovel of dirt. Which is doing the most useful work? How is it, when they all throw full shovels and keep busy right along? The ditch deepens almost magically. That's it! That's efficient organization. The parts (shovelers) are all pulling together to produce useful work (the ditch).

Second, what is the most efficient organization in this world today?—Not on your life. Not the turbine, gas engine, boiler, or any such thing. It is old Dame Nature, as embodied in the human body. Where can you find a machine whose length of useful life is from 60 to 70 yr.? Where is a machine that can do useful work day after day without long layoffs for repairs, even when properly treated? If you put emery in the bearings of a steam engine or oil in a boiler, you hear about it mighty quick; however, you can eat all sorts of things, use tobacco and drugs, drink alcohol, and generally abuse the human system and it will stand more of this kind of abuse than any machine ever made, before it breaks down.

There you have it, then, the finest possible example of an efficient organization for copying after. Let us just study its component parts a moment and then our readers can draw comparisons with the concrete examples to be set forth presently. What are the component parts? They are numberless and have long Latin names, but those that interest us are few and have simple names: (1) The brain, which plans and directs. (2) The eyes, ears and nose, which are the watchmen, or watch engineers, who see that everything is O. K. and goes as the brain directs. (3) The hands, arms and feet, which carry out the orders of the brain under the direction of the eyes, ears and nose. You know how they work. Can you beat it—the way they all pull together?

In addition, the stomach may be compared to the steam boiler and the heart to the engine. Feed the stomach the right food and with regularity, and you have no trouble with the heart. Abuse the stomach, and you have indigestion and heart trouble. Therefore we may state again, make your organization in your plant as nearly like the human system as you can, and you will have an efficient organization. Don't forget that cleanliness, proper air, regular habits, etc., are all conducive to efficient organization.

We will now pass on to the concrete and take up our subject in its three practical phases; namely, in the central station, the office building plant, and the industrial plant. The organization of all three is similar, but certain differences exist which make it worth while to go into each phase in detail.

The Central Station

At the head of the central station is the chief engineer, mechanical superintendent, superintendent of power, man-in-charge, or whatever else he may be called. It is his duty to plan and direct. He is the one to whom both directors and employes look for results, although not always for the same results. He is the "go-between" from the employes to the employers. He is the man who really builds up an efficient organization and must also be "Johnny on the spot" in case of accident or emergency.

The chief engineer must keep two main points always before him: First, to maintain uninterrupted service, both on power and lighting busses. Second, to produce electricity at the bus bars at the lowest compatible cost. What is the central station built for? To sell electricity for power and light at a profit. Therefore, the service must be continuous, as regards power, or manufacturers will install their own power plants and the company will lose business. As regards light, the danger to life and property through break-downs of lights systems are quite obvious. Therefore the chief engineer must study his output curves and load curves so that he will always have plenty of reserve capacity, in the event of one of his units breaking down. He must be in early with his "holler" for additional capacity when he sees his reserve being encroached upon by increasing load demands and he must "holler" loud, as those above him are always more interested in the incoming rather than the outgoing dollar.

Now we come to the second point. The central station is in business to sell electricity *at a profit*. In order to do this, it must be made at as low a cost as possible, or competition will spring up, in the form of small private plants, which will soon put it out of business if its rates go too high. It is, then, the duty of the chief so to organize his force that he can produce electricity at a low cost. He must produce electricity with a minimum of human labor, and to do this the whole force must pull together. A discontented, shirking force means more men to do the work, and labor is costly. Therefore, the chief should endeavor to see that the men under him are contented with their work, wages and working environment and that each man holds a position for which he is best suited, both physically and mentally. A chief engineer should make a tour around his station several times a day to see that the work is being properly done, the machinery kept in good repair, and to speak to and hear any complaints from the men. He will in no way lower his dignity doing this and the force will feel that he takes a personal interest in them and will work harder to please him. An *occasional* word of commendation, when deserved, is very helpful. Then again, when the watch engineers know that the chief will look over the machinery, they will be a little more particular in keeping it clean and running right.

Submit Regular Reports

The chief engineer should send a regular *brief, neat* report to his superiors concerning the plant and its operation. Then when the time comes for additional machinery, no long discussions and explanations will be necessary, as the situation should be clear to the minds of all concerned.

The chief should, of course, keep a report of coal consumed, feed water temperature, water evaporated, electricity produced, pay-roll, repair and maintenance, expense, etc. These records can profitably be plotted out on cross section paper and studied, as changes are made, to determine the actual value of each change as the curves go up and down. He should take his watch engineers into his confidence and bring to their attention the value of the changes as exemplified by the curves. He should also be ready to teach and help those under him and win their confidence so they will *pull* with him.

A concrete illustration or two may be in order, taken from the writer's code.

I always try to train the men under me so that, barring accidents, things will go along as well whether I am there or not. There are several reasons for this. I am not afraid of losing my job to a man under me, for I am now as good or better than he is, or I wouldn't be here. I have found it invariably true that in teaching him something, I learn more from him, thus I keep a little better than he is, all the time. Next, I have more freedom and less on my mind when I am away, as I know everything will be O. K. Finally, when my employer has a better job for me, he does not have to hold off and find a man to take my job first. I have a man already trained for him. If he has to find a new man for my job, he may as well get one for the better job and leave me in my old one.

Getting the Fireman Interested

Second example: I have a chief engineer and he has three boiler rooms under him. The firemen are all foreigners, and most of them cannot read or write. I told the chief to make up a curve, showing the coal consumed for this year in one of the boiler rooms and hang it up in the boiler room, without saying a word. He is keeping it posted up to date every week. It has been up a week or two now and all the firemen are crazy to know what it is. They go from one boiler room to another and discuss it every chance they get. Very soon we are going to put up curves in the other two rooms. Then curves of feed water temperature and finally evaporation. Curiosity is a human failing, and before long the men will find out the meaning of the curves. They will note that the coal, evaporation and feed temperature curves rise and fall together. Then there will ensue a rivalry to keep the curves down; that is, the coal curve down and the others up. If necessary, a little extra in the envelop for the best performance, to stimulate this rivalry. Not a bonus. Oh, no! If we gave a bonus, it would be expected all the time, as I have seen before. Just a dollar or two extra apiece to the men in the best boiler room each week and then just point to the curves when they ask for the reason for the extra money. Isn't it just like teaching a baby the alphabet with A, B, C blocks or an alphabet book? Try it and see. I have, and it works. While you are doing it, don't explain anything. Curiosity will take care of that. When you have gone that far, you can show the men better firing methods, etc., and the changes in the curves, which they will watch by then, will show them the value of your changes. Then you have won their confidence and they will pull solidly with you in the future. Of course, changes in the force will take place

from time to time, but there will always be enough of the old men left to stimulate the new. How far would you get if you talked B.t.u. and thermal efficiency to men who cannot read or write? Not far, I guess, but they understand the dollar sign, as applied to their own pockets, well enough.

The duties and scope of the chief have now been outlined and the next men on the force, the watch engineers will now come up for consideration in a briefer but more detailed way.

Before leaving you, Mr. Chief Engineer of a Central Station, let us remind you that you are in a harder position than Mr. Chief of Office Building or Industrial Plant, because he can in almost every case fall back on the central station in case his machinery gives out, while you have only your reserve (such as your own planning and efforts have provided) to fall back upon, in case of accident. If his plant fails and he cannot fall back on you, it puts only one plant or building out of commission, while failure of your plant means oftentimes a city in darkness or a large number of manufacturing concerns shut down, with the resultant loss of work temporarily to thousands of wage earners. So watch your RESERVE CAPACITY.

Deflection of Steam Pipes

Derivation of Formulas and Chart for Rapid Calculation. By H. M. Brayton

IT IS often highly important that we know the amount of deflection which we may expect in our steam pipe should the unexpected happen and the line fill with water. This deflection should be determined when the piping system is first laid out and the spans between the hangers arranged so that this deflection is within reasonable limits.

In previous articles the writer has discussed ways and methods of determining stresses in the steam line and has given charts for span determination for a given stress. It may well happen, however, that the designer for some reason, either through necessity or otherwise, is desirous of putting in a long span and letting the stress run high. In this case, the deflection should be considered and care taken that should the pipe sag it will not bring its weight to bear on another pipe below which may not be able to stand the added weight. In cases where but little clearance is allowed between pipes, a small amount of deflection might be serious.

The average engineer and designer is quite loath to do much calculation on deflection. To the average draftsman who has not had extensive work in applied mechanics, it presents difficulties which are surrounded with mystery. If he cannot find the solution in a handbook, he usually guesses at the answer, which, to say the least, is unscientific and out of date.

The writer wishes to show here the method of derivation of these formulas and then show how easily a chart may be drawn to eliminate all calculation. The problem would be much simplified if we were not obliged to consider the pipe filled with water. This is quite necessary, however, as it adds considerably to the weight and is not an uncommon thing to have happen. We must first determine the total weight of the pipe filled with water:

Weight of pipe $= 2.75\ (D^2 - d^2)$. This includes ends. (Eq. 1)

Weight of water $= 0.785 \times 12 \times 0.036\ d^2 = 0.34\ d^2$. (Eq. 2)

Adding these gives the total weight of pipe and water per foot in length.

Weight (total) $= 2.75\ (D^2 - d^2) + 0.34\ d^2 = 2.41\ (1.14\ D^2 - d^2)$ (Eq. 3)

We have, then, in this case a continuous beam, and in order to obtain an exact solution we should have to apply the three moment equations. If the reader is familiar with these three moment equations he will readily realize why engineers avoid them whenever possible. They are very complicated, tedious to use, and the more accurate results are not warranted in most practical cases. They are, moreover, subject to serious errors if the level of all the supports is not the same. These conditions all lead the practical engineer toward the use of the simpler formula for an ordinary beam supported at two points and uniformly loaded. This relation is well known and given by

$$\text{Def.} = \frac{5\ W' L^3}{384\ E\ I} \qquad \text{(Eq. 4)}$$

in which W' = the total weight of pipe and water between supports.

L = length between supports in feet.

E = modulus of elasticity = 30,000,000 for steel.

I = moment of inertia of pipe about a diameter.

Def. = deflection of pipe at center in inches.

We must put all of these factors into the same units and we may simplify equation 4 considerably.

$$W' = W\ L \qquad \text{(Eq. 5)}$$

in which W = weight of pipe and water per foot. W is given by equation 3.

$$I = \frac{3.1416}{64}\ (D^4 - d^4). \qquad \text{(Eq. 6)}$$

in which D = outside diameter of pipe in inches.

d = inside diameter of pipe in inches.

We may then proceed to substitute equations 5 and 6 into equation 4, from which we obtain the following:

$$\text{Def.} = \frac{5 \times 1728\ W\ L^4\ 64 \times 2.41\ (1.14\ D^2 - d^2)}{384 \times 30{,}000{,}000 \times (D^4 - d^4)}$$

$$\text{Def.} = 0.000{,}036{,}8\ \frac{(1.14\ D^2 - d^2)}{(D^4 - d^4)}\ L^4 \qquad \text{(Eq. 7)}$$

Equation 7 may be simplified and written thus:

$$\text{Def.} = C\ L^4 \qquad \text{(Eq. 8)}$$

$$\text{in which } C = 0.000{,}036{,}8\ \frac{(1.14\ D^2 - d^2)}{(D^4 - d^4)} \qquad \text{(Eq. 9)}$$

There are various standards for steam pipe. Some are made from cast iron, some from steel and others from wrought iron. Pipes also vary in size. Because of all these variations, it is necessary to apply these formulas separately to each class of pipe. The writer will show how they are applied to one class and the reader may then apply the same methods to whatever class he may have occasion to use.

Take from any standard table of pipe sizes the inside and outside diameters for the various sizes of "Extra Strong" pipe. The value for E in the fundamental equation 4 was taken at 30,000,000, which applies to wrought iron and steel. The above derivation holds good for this class of pipe. Had we selected a cast-iron pipe, the value of E would have been 12,000,000. With the values of D and d taken from the table we may calculate the value of the constant C from equation 9. The writer has done this for the one class of pipe. It may seem at first to be a tedious job, but it is soon accomplished with the aid of a slide rule. It is best to arrange the data in the form of a table. This avoids confusion and reduces errors to a minimum. Such a table is given below.

EXTRA STRONG WROUGHT PIPE

Nominal size inches	Outside diam. D, inches	Inside diam. d, inches	Value of C in Def. $= C L^4$
2	2.37	1.94	0.000,005,32
3	3.50	2.90	0.000,002,58
4	4.50	3.83	0.000,001,58
5	5.56	4.81	0.000,001,03
6	6.63	5.76	0.000,000,750
7	7.63	6.63	0.000,000,600
8	8.63	7.63	0.000,000,468
9	9.63	8.63	0.000,000,371
10	10.75	9.75	0.000,000,310
11	11.75	10.75	0.000,000,270
12	12.75	11.75	0.000,000,235

It will now be apparent that equation 8, being a simple three variable equation, may be charted so that the value of the deflection may be quickly determined for this class of pipe. Refer now to the chart shown herewith. At the left we have a deflection scale ranging from zero to 0.55 in. Along the bottom of the chart for the abscissa we may imagine the C scale ranging from zero to 0.000,005,5. This need only be penciled upon the chart during construction, as it is of no value afterward. With the C scale for the abscissa and the deflection scale for the ordinate, we may proceed to plot equation 8 by assigning different values to the span L. For example, let $L = 30$ ft. Then the equation becomes

$$\text{Def.} = C L^4 = C\,(30)^4 = 810{,}000\,C \quad \text{(Eq. 10)}$$

which is merely a straight line through the origin and is labeled on the chart $L = 30$ ft. Proceed in this manner by substituting values for L throughout the desired range, thus obtaining the equations of the lines from which they may be drawn in.

If we stopped here with our chart, it would not be complete, because it would be necessary whenever one desired to solve a problem on it to look up the value of the constant C which went with the size of pipe being considered. All one should need to know in order to solve a problem is the nominal size of pipe and length of span.

Suppose we plot the value of the constant C against the nominal size of pipe; in other words, the values given in the first column of our table against those in the last column. We already have the C scale plotted as abscissa, so it will only be necessary to put in the size scale at the right as ordinate; this has been done on the chart. When these values are plotted and connected by a smooth curve the results are as shown.

Reading the Chart

It is indeed a simple matter to solve the problem of deflection with a chart of this kind. The dash line illustrates a problem where the size of pipe has been taken at 4 in. and the span at 20 ft. Merely find the pipe size at the right on the vertical scale. Move horizontally until the curve is reached, then either up or down until the span line is met, then horizontally to the left-hand vertical scale. The illustration shows that a 4-in. pipe hung on 20-ft. centers will, when filled with water, give a maximum deflection of 0.255 in. The converse problem may, of course, be solved also; that is, when one desires to find the maximum allowable span for a certain size pipe at a given deflection.

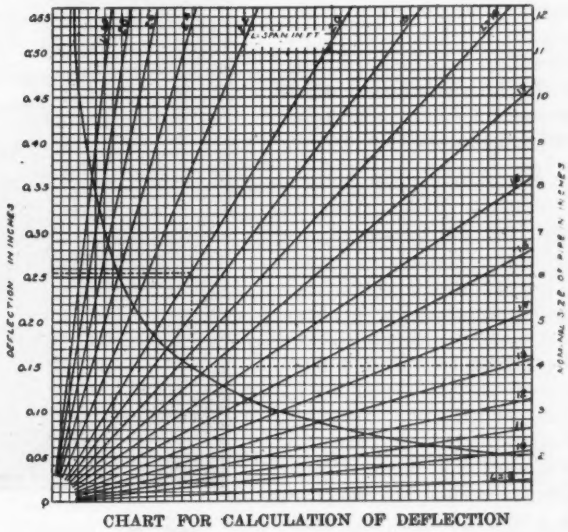


CHART FOR CALCULATION OF DEFLECTION

The reader must bear in mind that this particular chart applies only to this one class of pipe. Anybody may build up his own chart by simply following the schedule outlined herein. One point must be observed carefully, and that is the value of the modulus of elasticity E in the fundamental formula of equation 4. If the reader builds up a chart for cast-iron pipe, the value of E will be 12,000,000 and not 30,000,000. Equation 9 would then become:

$$C = 0.000{,}092\,\frac{(1.14\,D^2 - d^2)}{(D^4 - d^4)} \quad \text{(Eq. 11)}$$

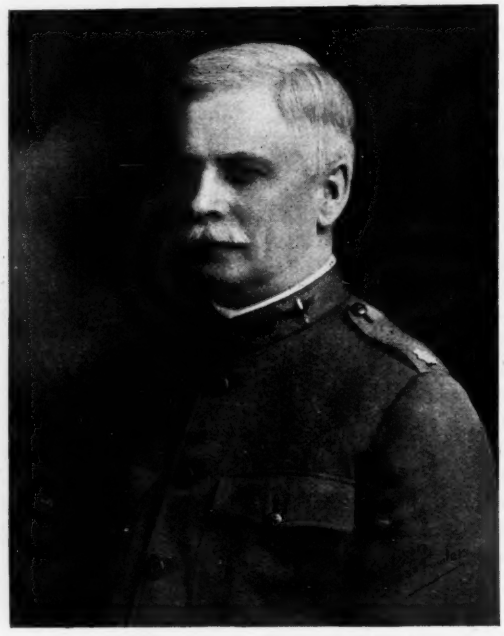
which means that the deflection with cast-iron pipe is 2½ times what it is with wrought or steel pipe. Equation 11 would in this case be used in calculating the value of C for the table. The rest of the procedure would be the same as for wrought pipe.

"Some people get results if kindly encouraged, but give me the man who does things in spite of hell."

BION J. ARNOLD

RAN AWAY TO OPERATE STEAM THRESHER. IMPROVED STORAGE BATTERY AND DEVELOPED SINGLE PHASE ELECTRIC TRACTION. A REAL PUBLIC SERVANT. BY WALTER PAINTER

IF YOU lived on a farm out in eastern Nebraska during 1875-77, possibly you observed the extreme youth and enthusiastic labors of the slim little chap in charge of the old puffing threshing engine which rolled slowly along the road and into your field. Or, as he came in at noon, to eat with the "hands" you may have observed in his boyish face a gleam of his earnestness of purpose, for he had a fixed goal and meant to gain it. I wonder if you knew that he was a runaway, or that he was subsequently to become an engineer of international renown.



Mr. Arnold was born at Casenovia, Mich., Aug. 14, 1861, the son of Joseph and Geraldine (Reynolds) Arnold, When he was 3 yr. old, the family emigrated to Nebraska and spent 4 yr. on a farm, the father becoming a member of the territorial legislature, and finally moving to Ashland where he practiced law until his death. Naturally, he wished his eldest son to adopt the legal profession, but the boy's strong desire for mechanical work constantly directed his mind and eventually determined his path. He wanted to be "an engineer," the aspiration so common to boyhood, but so seldom realized to such a remarkable degree.

His father's lack of patience with his constant "tinkering" caused him to leap the domestic barrier and run away at the age of 14, to join a steam threshing crew. For two years, he followed the crew as its "engineer." This experience brought him to a realization of his limitations and possibilities that later caused him to heed parental advice and secure an education.

His mechanical genius developed early. When only six, he began to make small boats, sleds and models of farm implements; at twelve, he made a small steam engine, devising and employing the common piston valve before he had seen it elsewhere, and in his seventeenth year constructed a bicycle from a small advertising cut which he had seen in a magazine. A year later, while at the University of Nebraska, he produced a complete working model locomotive one-sixteenth full size. These were all constructed in a new country, devoid of machine shops or factories, under the most adverse conditions, using such tools as were available at the local blacksmith shop, and with little encouragement.

As the State University did not then include a mechanical engineering course, he was attracted by the opportunity offered by the Navy to secure an engineering education and, after studying at the University for one year, he secured an appointment authorizing him to appear for examination as a cadet engineer at the U. S. Naval Academy, Annapolis, but, on the advice of Naval officers, did not enter, as they told him that with his strong inclination toward mechanics and his restless disposition he was not particularly adapted for the life of a naval officer, and that if he applied himself as strenuously in civil life as he would have to if in the Academy he ought to do much better.

He then took a four-year academic course at Hillsdale College, Hillsdale, Mich., paying his expenses during the last two years of his course by traveling summers for engine manufacturers. He received the mathematical prize for the course and three years later was awarded the degree of Master of Science. In 1889, the same institution conferred upon him the degree of M.Ph. for engineering work accomplished subsequent to graduation and, in 1903, an unusual honor in the form of a "Diploma Extraordinary" in recognition of his "distinguished learning and achievement in invention and in mechanical and electrical engineering."

On the day after his graduation in 1884, he went to work as a general agent and expert for the Upton Mfg. Co., Port Huron, Mich., builders of traction engines, and traveled throughout the United States in this capacity for a year and a half and thus secured his first

business training. He then entered the employ of the Edward P. Allis Co. (now the Allis-Chalmers Co.), as a draftsman, and a few months afterward was offered a position as chief designing engineer of the Iowa Iron Works at Dubuque. While there, he designed much heavy machinery and numerous steam engines of large capacity. In 1887, he resigned to become mechanical engineer for the Chicago & Great Western R. R., for whom he redesigned some of their locomotives and prepared drawings for new equipment.

Up to this period, it had been his intention to acquire a general experience in different branches of engineering work. He now determined to make electric railroading, then in infancy, his particular profession, and prepared himself for this work by spending the winter of 1888-89 in post-graduate work at Cornell University. After leaving Ithaca, he engaged with the Thomson-Houston Co. and was put in charge of its St. Louis office. Later, 1890-93, he acted as consulting engineer for this company, after it had been consolidated with the General Electric Co. In this capacity, he designed and built the Intramural Railroad at the Chicago World's Fair, the first commercial third rail installation and forerunner of the present elevated electric railway.

So successful was this electric road that Mr. Arnold decided to begin independent consulting work and opened an office in Chicago in 1893. His marked ability as an electrical engineer, combined with his talent for mechanical construction, soon placed him at the top of his profession. Unfolding completely the interesting scenario of his broad and varied engineering experiences is beyond the compass of a brief sketch. His achievements came as numerous and rapidly as a stream of machine-gun bullets.

Although the use of storage batteries, except in laboratory work had been a failure, he was early impressed with their ultimate value for use in electric traction and lighting plants, and as a result of experiments in his basement laboratory, he perfected plans for their use and introduced them on a large scale in many important installations. In addition to his storage battery work he invented a magnetic clutch and other valuable devices.

One of his first works in pioneer electric railroading was the equipment of the Chicago & Milwaukee Electric Railroad, with a substation storage battery and rotary-converter system, employing high-tension alternating current for power transmission. In this work, the first of its kind, opposition to his ideas, owing to change in the road's ownership during construction, was so great that he voluntarily assumed the entire engineering and financial risk under a bonus and forfeiture contract, in order to demonstrate the merits of his plan. This plan was successful and not only materially reduced the first cost of construction of electric railroads, but also effected great economies in operation, with the result that the system became standard, and is best exemplified in the mammoth electrical installation of the New York Central Terminal. Thus not only was his faith in his ideas proven, but their correctness quickly recognized by others.

Developing single-phase electric traction was another of his outstanding achievements. It resulted from a series of experiments during 1900-04 at Lansing, Mich., with an electro-pneumatic system of his own invention. This work involved a personal expense of over $40,000 and further indicates his pioneer experimental spirit. It caused the principal electrical manufacturers to develop an alternating-current system which has since been largely used, its highest form of development probably being the St. Clair tunnel installation of the Grand Trunk Ry. between Port Huron, Mich. and Sarnia, Ont., devised and installed by him, and the New York, New Haven & Hartford R. R. installation between New York and Stamford, Conn.

His sound advice regarding steam and electric railway terminals and traction matters in co-operation with scores of municipal, civic, and commercial bodies has been instrumental in the marked improvement of public utilities and public welfare. His services as consulting engineer, director of appraisals and author of reports have wisely directed the course of large interests in engineering matters throughout this and foreign countries.

In 1901, the New York Central Railroad commissioned him to study the feasibility of electrically operating its trains in and out of New York City and, from 1901-06 he was a member of the commission in charge of the electrification of over 300 mi. of the company's terminal tracks.

In just four months after the City of Chicago had engaged him in 1902 to make an exhaustive study and report of its entire traction system, he produced a 300-page report covering a scientific analysis of the situation. His recommendations were adopted and formed the basis of a comprehensive system of surface railways, costing $150,000,000, which he later developed as chairman of the Board of Supervising Engineers created by ordinance in 1907 to carry on this work. Numerous subsequent reports to the city were made by him individually upon various phases of the traction situation, including complete plans for a subway system and later, as a member of the Chicago Traction and Subway Commission, he assisted in the formulating of a complete engineering, operating and financial plan under which all of the surface, elevated lines and proposed subways of the city could be co-ordinated into a unified traction system for the entire city. In 1913 he was commissioned by the Citizens' Terminal Plan Commission of Chicago to review plans submitted by the Pennsylvania Railway Co. and several others for terminals, and to recommend a comprehensive system of steam railway terminals for the city. The recommendations embodied in his report were largely followed, resulting in the creating by the City Council of the Chicago Ry. Terminal Commission to coordinate the work, and in his appointment as a member of it. In 1914, as a member of the Commission, he spent considerable time studying the railway terminals and harbors of Europe. Early in 1916, he was engaged by the Public Service Commission of Massachusetts to review certain valuations and operating costs of the electric railways surrounding Boston. In his report, he indicated how economies aggregating $750,000 annually could be effected.

In 1918, he was retained to act as Chairman of a Board of Advisory Engineers to the city of New Orleans to determine the feasibility of crossing the Mississippi river by means of a bridge or tunnel for carrying the

steam railways entering that city from the west and co-ordinating the various steam railways and the Belt Line Railway into a comprehensive terminal system. This report, which was recently delivered, showed such an installation to be not only feasible but advisable.

He has recently been appointed, on account of his knowledge of conditions on the Great Lakes, and his wide experience with transportation matters generally, a member of the United States Shipping Board Port Facilities Commission, of which Major-General W. M. Black, Chief of Engineers, U. S. A. is chairman.

In 1915, he was appointed by the American Institute of Electrical Engineers chairman of its committee to co-operate with the other national engineering societies in formulating some plan whereby the services of the civilian engineers of the country should be organized and made available to the Government in time of war. These committees selected their respective chairmen, five in all, to act as an executive committee, authorized to confer with the army and legislative officials at Washington, with the result that the Engineer Corps bill was formulated which, before it finally passed, grew into the Officers' Reserve Corps act, under which so many civilians were commissioned to serve as officers during the World War. Mr. Arnold was one of the first to receive a commission, that of Major of Engineers on Jan. 23, 1917; but on account of his civilian duties and his activities as a member of the Naval Consulting Board of the United States, he did not enter active service in the Army until late in 1917.

Since 1889, he has been interested in aeronautics. At the Chicago World's Fair, he was a member of the aeronautic committee. The efforts of Octave Chanute received his close attention and he followed the development of aeronautical work from a scientific standpoint and closely witnessed, as the guest of Army officers, the pioneer flights of Orville Wright at Ft. Meyer, Va. This scientific interest in aviation caused him to choose the Air Service of the Army in preference to the work of the regular engineering corps or the railway corps of the Army, so that when he was called into active service on Dec. 24, 1917, although then being a Major of Engineers in the Reserve Corps, he was promoted and entered as a Lieutenant Colonel in the Air Service. His experience in engineering matters was utilized by both the Army and the Navy in many directions which space does not permit enumerating. In his line of duty he traveled about 2000 mi. by airplane or seaplane in the Central States, across California, Texas, Louisiana and the Everglades of Florida. At the time the armistice was signed, he was associated with the inventors and had command for the Army of the development of the aerial torpedo, an automatically controlled airplane, propelled by its own power, designed to fly without the guidance of a human hand, to carry from 200 to 1000 lb. of high explosive, and to be aimed at an enemy from 50 to 100 mi. distant. This device had reached the quantity production stage at the time the armistice was signed and would have been in use by the thousands on the Western front had the war lasted a few months longer. He is a member of the Aero Club of America and served as president of the Aero Club of Illinois, 1912-13. He has been active in assisting in the organization of the American Legion, being one of the State Committee for Illinois.

One of his characteristics is to keep in advance of his profession. Many of his solutions of engineering problems have been carried out against strong opposition. As he demonstrated the success of one after another, adverse criticism turned to well-merited praise. Another element of his character is shown in the fact that on three distinct occasions in his early career as an engineer, he withdrew from profitable positions at a financial loss to undertake work giving experience which he considered essential to his ultimate success.

He has been a careful student and an earnest investigator of electrical phenomena. Technical electrical literature has been enriched by his papers and discussions before the principal engineering societies of which he is a member. In 1903-4 he served as president of the American Institute of Electrical Engineers—the first Western man to receive this honor—and was president of the Western Society of Engineers in 1906-7. As an appreciation of his achievements, several universities and technical schools and numerous engineering and civic bodies have awarded him degrees, diplomas, medals and other honors, the full listing of which would require a column.

He has had many hobbies, which center chiefly in his work. Each new project is eagerly attacked, wrestled with until it is exhausted, and then he seeks a new one. Just now an interurban road about 40 mi. long, owned by him, is engaging much attention. Enthusiasm, that irresistible quality which, as someone has aptly said, "makes a man boil over for his business, for his family, or for anything his heart is in," is one of Mr. Arnold's dominating traits, and in long hours of what many would term intensely hard work he finds his happiest recreation.

When asked for a word of advice to young engineers, he repeated that given him by Dr. Dewitt C. Durgan, president of Hillsdale College at Commencement in 1884. Dr. Durgan, on noticing a large floral model of the locomotive built by Mr. Arnold as a boy being brought up the aisle, handed him his diploma with the words: "Hitch your engine to a star."

To assist in the conduct of engineering research and to extend and strengthen the field of its graduate work in engineering, the University of Illinois maintains 14 Research Graduate Assistantships in the Engineering Experiment Station. Two other such assistantships have been established under the patronage of the Illinois Gas Association. These assistantships, for each of which there is an annual stipend of $500 and freedom from all fees except the matriculation and diploma fees, are open to graduates of approved American and foreign universities and technical schools who are prepared to undertake graduate study in engineering, physics, or applied chemistry. An appointment to the position of Research Graduate Assistant is made and must be accepted for two consecutive collegiate years, at the expiration of which period, if all requirements have been met, the degree of Master of Science will be conferred. The work of the Engineering Experiment Station is closely related to that of the College of Engineering, and the Heads of Departments in the College constitute the Executive Staff of the Station. Additional information may be obtained by addressing The Director, Engineering Experiment Station, University of Illinois, Urbana, Illinois.

Reading Chimney Losses Direct From CO_2 Charts

USE OF SPECIAL SCALES. SHOWING WHY THE AVERAGE CO_2 DOES NOT INDICATE THE CHIMNEY LOSS. BY C. C. PHELPS

THE GREATEST single loss in any steam power plant is the heat thrown away up the chimney. In order to keep this loss as small as practicable and thereby reduce the coal bill as much as possible, we must strive for a low stack temperature and the practical minimum excess of air passing through the fuel bed. It is an easy matter to keep track of both of these factors; the former by means of a pyrometer, and the latter by determining the percentage of carbon dioxide (CO_2) in the flue gases. The percentage of CO_2 serves as an ideal guide to determine the air excess, for the reason that the percentage of CO_2 varies inversely as the percentage of excess air; that is, the less the excess of air, the greater will be the percentage of CO_2 in the flue gas. There are practical limits of both CO_2 and stack temperature beyond which it is not advisable to go, but the foregoing rule holds for all cases within these limitations.

The importance of the chimney loss is well covered by Professor George F. Gebhardt in his book "Steam Power Plant Engineering" as follows: "The magnitude of this loss depends chiefly upon the air dilution and the temperature at which the gases are discharged. Flue temperatures less than 450 deg. F. are seldom experienced, except in connection with economizers and the air dilution is ordinarily in excess of 50 per cent of

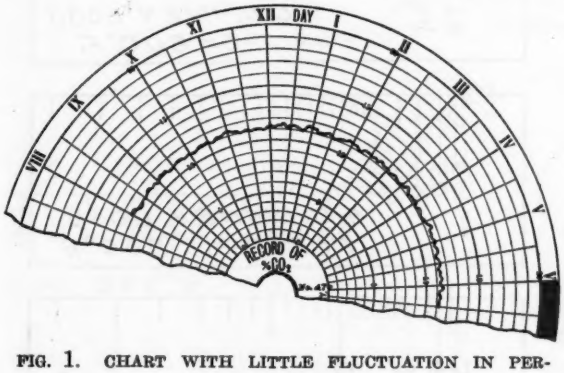


FIG. 1. CHART WITH LITTLE FLUCTUATION IN PERCENTAGE OF CO_2

theoretical requirements, hence the loss from this cause may range from 8 to 40 per cent of the total heat generated."

COAL CONSUMPTION REDUCED 10 TO 20 PER CENT

WHEN THE PERCENTAGES of CO_2 and the stack temperature are determined by frequent measurements, or, better still, by means of continuous records, it is a simple matter to regulate the air dilution to the lowest practicable limit by making suitable adjustments of drafts and dampers, as well as by making any other furnace modifications or adjustments that may be demanded by local conditions. In this way it has been possible in many power plants to reduce the chimney loss one-quarter to one-half. Expressed in dollars and cents, this means reducing the coal bill by 10 to 20 per cent.

HIGH AND UNIFORM CO_2 DESIRABLE

IN ADDITION to a high percentage of CO_2, a uniform proportion of CO_2 is highly desirable. In other words, a relatively flat, continuous CO_2 record, as Fig. 1, is preferable to an equivalent fluctuating one, as Fig. 2. In fact, it is possible to secure greater efficiency with a flat curve like Fig. 1 than with a fluctuating one like Fig. 2, even though the average values of the two curves are identical. The reason for this apparently paradoxical statement will be understood after reading the following paragraphs. It is noted that usually a flatter record is obtained with automatic stokers than with hand firing and that fact indicates one of the advantages of stoker furnaces.

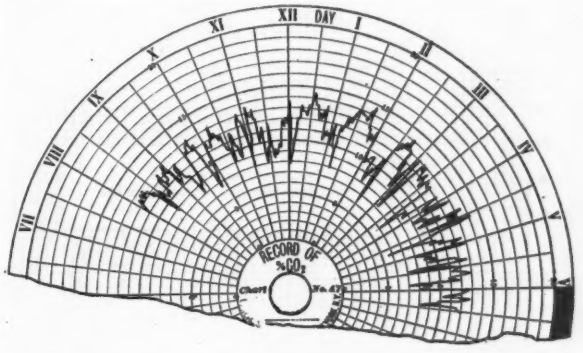


FIG. 2. CHART SHOWING A WIDE FLUCTUATION IN CO_2 PERCENTAGE, TO BE AVOIDED

The relation between the percentage of CO_2 and the per cent of the total heat of fuel that is lost up the chimney is clearly shown in Fig. 3. The curves in this chart representing various stack temperatures are based on the complete combustion of pure carbon as fuel and make no allowance for hydrogen, sulphur, ash, or other constituents in the fuel. The curves are approximately correct for coal containing a high percentage of carbon. In order to arrive at accurate results for coals high in other constituents, it would be necessary to employ other curves or make corrections by calculation. To present curves covering all the various possible constituents of coal would require more space than is available for the present article. The curves for pure carbon, Fig. 3, will, however, serve to illustrate the principles underlying flue gas loss determinations for any fuel.

Figure 3 shows up some very interesting facts. In the first place, for equal percentages of CO_2 in the flue gases, the losses up the chimney are directly proportional to the stack temperatures, when the latter are expressed in the form $(T - t)$, where T is the stack temperature and t the atmospheric temperature in degrees Fahrenheit. For example, with 10 per cent CO_2, the heat lost up the chimney is 12½ per cent for $(T - t = 300$ deg.) and twice as much, or 25 per cent for $(T - t = 600$ deg.). It will be noted further from all of these curves

that for a given stack temperature the proportion of heat wasted up the chimney is greater as the per cent of CO_2 is less, and, further, that for each successive drop of one degree in percentage of CO_2, the heat loss becomes relatively greater. For instance, on the "T—t = 600 deg." curve, a drop of CO_2 from 15 to 14 per cent results in an increase of heat lost up the chimney from 17 to 18 per cent; that is, an increase of 1 per cent in the loss, whereas with a drop of CO_2 from 5 to 4 per cent, the heat lost up the chimney under the same temperature conditions increase from 49 to 61, the increase in heat loss being 12 per cent in the latter case. It will now be apparent why a fluctuating record indicates inefficient consumption of fuel. Referring to Fig. 2, the heat losses corresponding to points on the inner loops

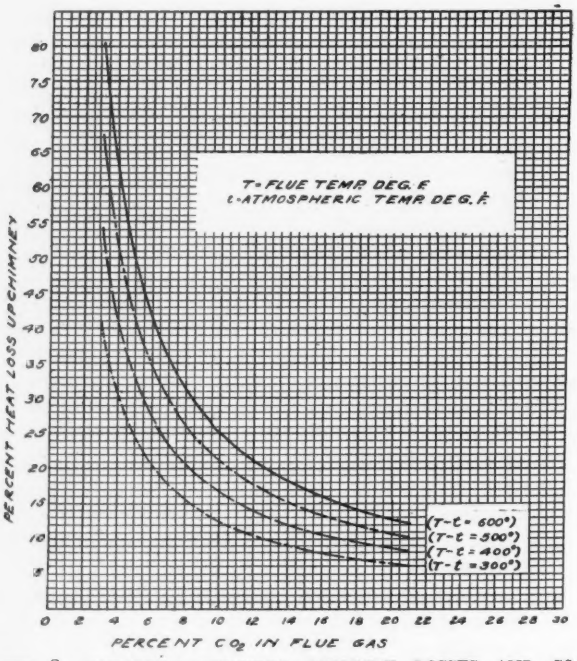


FIG. 3. RELATION BETWEEN CHIMNEY LOSSES AND CO_2 PERCENTAGES, BASED ON CARBON

of the diagram are high out of all proportion, compared with those corresponding to points located farther out radially.

Method of Averaging Heat Losses

In order to arrive at the average heat lost up the chimney during a specified interval, some engineers erroneously follow the practice of averaging the CO_2 readings and then figuring out the corresponding average heat loss with this average CO_2 reading as a basis. The fallacy of this method is clearly demonstrated by Fig. 4, which represents a theoretical CO_2 chart record. This represents a constant percentage of CO_2 at 15 per cent during the 6-hr. period from 6 to 12 o'clock and at 5 per cent for the same length of time from noon until 6 o'clock. The average CO_2 percentage for the 12 hr. is obviously $\frac{15+5}{2} = 10$ and the loss corresponding to this figure for (T— t = 600) is 25 per cent (see Fig. 3). This, however, is not the true average heat loss. The latter is figured as follows:

$$\frac{\text{Heat loss with 15\% } CO_2 + \text{Heat loss with 5\% } CO_2}{2} =$$

$$\frac{17+49}{2} = \frac{66}{2} = 33 \text{ per cent average heat loss, with}$$

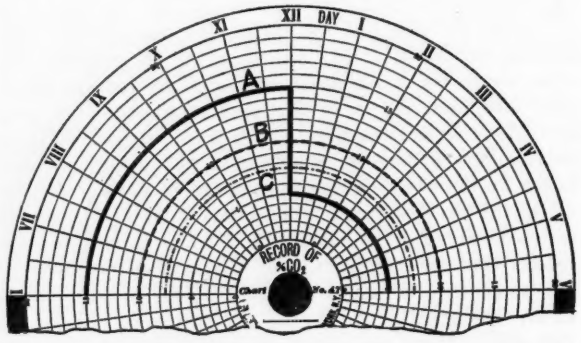


FIG. 4. THEORETICAL CO_2 CHART FOR 12-HR. PERIOD (A). AVERAGE CO_2 IS 10 PER CENT (B). TRUE AVERAGE HEAT LOSS FOR (T — t = 600) IS 33 PER CENT (C). NOTE THAT C CORRESPONDS TO 7½ PER CENT CO_2, NOT 10 PER CENT

(T— t = 600 deg.). The error figured by the incorrect method gives too favorable an impression of the heat loss

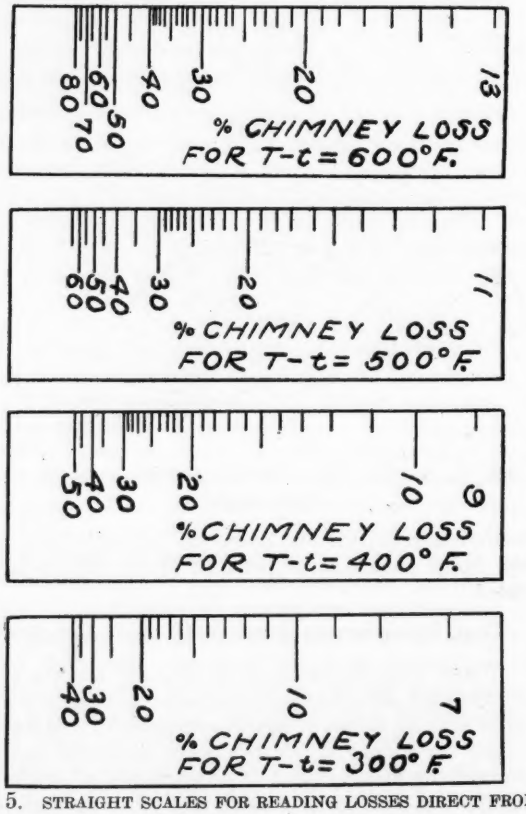


FIG. 5. STRAIGHT SCALES FOR READING LOSSES DIRECT FROM CHARTS AT VARIOUS FLUE GAS TEMPERATURES

by giving it as only 25 instead of 33 per cent. The incorrect figure is $\frac{33-25}{33} = \frac{1}{4}$ (approximately) too low.

The error in an actual case might be greater or less than in this assumed theoretical case, according to the conditions of operation. The greater the fluctuations in the chart record, the greater will be the error of using the incorrect method of figuring averages. With a smooth, flat CO_2 record, the error might be negligible; but even in such a case, it is poor practice to adopt a fallacious method of figuring, as there is danger of its becoming a habit and later leading to serious mistakes.

CO_2 Sampling Tank Versus Continuous Recorders

The fallacy pointed out above is likewise involved in the familiar method of collecting flue gases in a sampling tank during a more or less extended period of time and then basing calculations on the average per cent of CO_2 as determined by an analysis of this sample of flue gas. Furthermore, the sampling tank draws off a constant volume of gas during every unit of time, irrespective of the rate at which the gases are flowing up the chimney, hence it is impossible with that method to arrive at accurate results.

Special Scales for Measuring Heat Losses on CO_2 Charts

In figuring the average percentage of heat loss from a CO_2 chart the corresponding losses for a series of CO_2 readings may be determined from Fig. 3, but it is simpler to employ a special scale so as to take loss measurements directly from the CO_2 chart. Several scales adapted for various flue temperatures are reproduced in Fig. 5. These are correctly proportioned to be applied directly to typical CO_2 charts, and it is suggested that the reader preserve these scales.

In calculating the heat losses, the period of time to be covered, as represented by an arc of the chart, should be divided into 15, 7½ or 5-min. intervals, corresponding respectively to halves, quarters, or sixths of the chart sectors. The smaller these individual parts are made, the more accurate will be the final result; but it is not practicable to divide the intervals into smaller than 5-min. periods. Draw radii to correspond with these divisions. Then place the proper scale on these radii in succession, reading the flue gas loss directly from the scale. The average of all these readings represents the average heat loss over the period of time measured.

Figure 6 reproduces scales in a different form. This

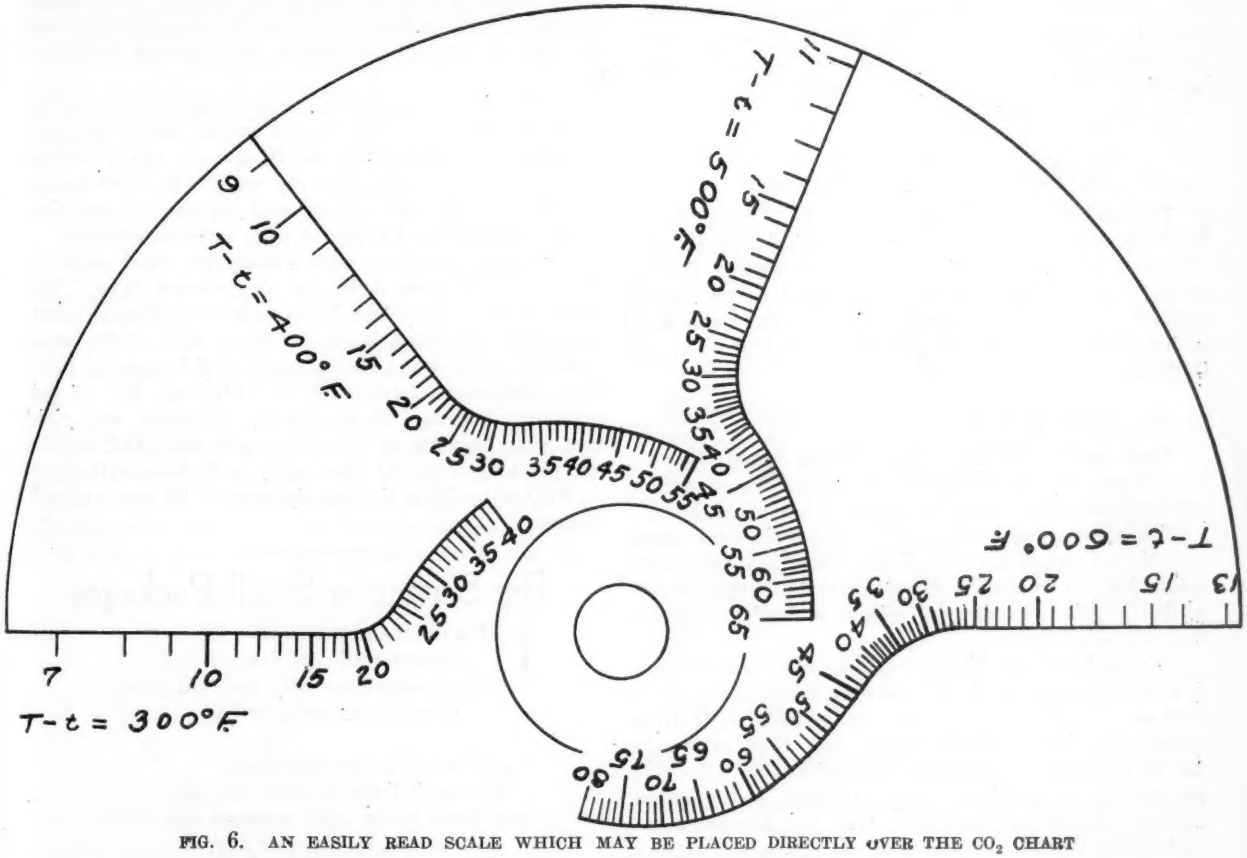


FIG. 6. AN EASILY READ SCALE WHICH MAY BE PLACED DIRECTLY OVER THE CO_2 CHART

is also of correct size to be used directly with Uehling charts. It is easier to read and is more convenient, inasmuch as it may be held concentric with the chart, so that it will always be ready for use by merely rotating it to the position for reading. This is accomplished by slipping the chart over a peg 9/16 in. in diameter and placing the scale in the same way above the chart. The scales of Fig. 6 are laid out for four stack temperatures, namely $(T - t) = 300$, 400, 500 and 600 deg. F.; thus this simple device may be used to measure the heat losses directly from the CO_2 chart under constant or varying stack temperature conditions.

A determination of the heat lost up the chimney is necessary in working out a "heat balance" and some-

times for other purposes; but in daily operation it is hardly necessary to go to this trouble, as the percentage of CO_2 in itself serves as a fair guide to the relative efficiency of operation.

The above calculations do not take into consideration all of the elements constituting the fuel, but it is a comparatively simple matter to make suitable allowances when an analysis of the fuel is at hand.

Having established the necessary dilution of the flue gases in order to obtain the most economical operating conditions for a given furnace and fuel, it becomes necessary merely to note the percentage of CO_2 required to satisfy these conditions and to keep to it as closely as possible. The CO_2 component of the flue gases thus becomes a reliable guide for the fireman and engineer. The more accurate the method of recording CO_2, the more efficiently will it be possible to operate the boiler plant, by keeping the CO_2 high and in as nearly constant proportion as possible. Hence it cannot be questioned that the continuous CO_2 recording method is the one of greatest reliability.

A New Year's Message

USUALLY the greeting sent out by a company to its employes is of the time-worn kind without personal thought, which is received with a feeling of more or less insincerity. Contrasted to the usual type of letter is the one reprinted below, which was sent to its employes by the Texas Power & Light Co., of Dallas.

To My Fellow Workers:

There is an ancient and wise writing which says:

"Today well lived makes every yesterday a dream of happiness and every tomorrow a vision of hope."

These lines have recurred to me again and again with the advent of the New Year. They are well worth pondering, for in them lies the secret of a happy, worthwhile life. To live today well—there couldn't be a better New Year resolution.

We all know that today is tomorrow in the making. It's the one moment in all eternity that is ours to do with as we will. We can waste it in inaction, fruitless speculation, idle wishing, empty talk that will make for us a future of discontent, confusion and failure, or we can fill it so full of loyal endeavor, honest effort, cheerful service and work well done that tomorrow will find us far ahead on the road of happiness and success.

You and I are members of a big industrial family. Therefore, at the beginning of this New Year, let us, as a family, resolve no matter what strife and change and confusion reconstruction may bring elsewhere, to *"sit steady in the boat,"* as the old saying has it, and thus keep peace and prosperity within our own borders. In other words, let's resolve right now to make every day of 1920 a day well lived!

There are no finer things in the world, my friends, than love and service and the satisfaction which comes from work well done. I can wish you nothing better than a year full and brimming over with just those things. Your fine spirit of loyalty and co-operation has made 1919 a year to be proud of and makes of 1920 "a vision of hope."

This letter comes as my personal New Year's greeting to each one of you, and as an expression of my appreciation of your splendid co-operation during the past year. May 1920 be indeed a Happy New Year for you in the fullest sense of the word.

Cordially yours,

J. H. STRICKLAND, PRESIDENT.

Windmills in "Parallel"

MONSIEUR P. FAYARD has succeeded in designing a type of windmill for power purposes which can be direct-coupled to the armature of the dynamo.

The power of a windmill propeller, says La Nature, is proportional to its surface, which, in turn, is proportional to the square of its radius; but the speed of rotation is inversely proportional to this radius. To increase the speed, then, without reducing the area there is only one way to diminish the radius and increase the number of propellers.

M. Fayard's experiments showed that by keying the dynamo armature direct to the motor shaft, carrying six propellers sufficiently widely spaced, an apparatus could be obtained satisfying the conditions of efficiency, smooth running, and safety, and capable of charging small accumulators by the aid of an automatic switch.

The work produced with a six-screw wind motor is more constant than with the single-screw type. The motor is more rigid and better able to withstand gusts, which do not attack it on the entire area at the same moment. It is stated that a motor of this type, of practical dimensions, having 10 m. (107.6 sq. ft.) of sail area, with screws 1.60 m. (63 in.) diameter, will yield in a wind blowing at 5 to 10 m. per sec. (11.2 to 22.4 mi. per hr.), a useful work of 5 to 20 hectowatts (500 to 2000 w.) with a six-pole dynamo of 60 per cent efficiency.

Big Service in Small Packages

I SERVE the rich and poor alike,
Always ready for instant call.
My quarters uncostly, any old place,
In cellar, or attic, or hall.

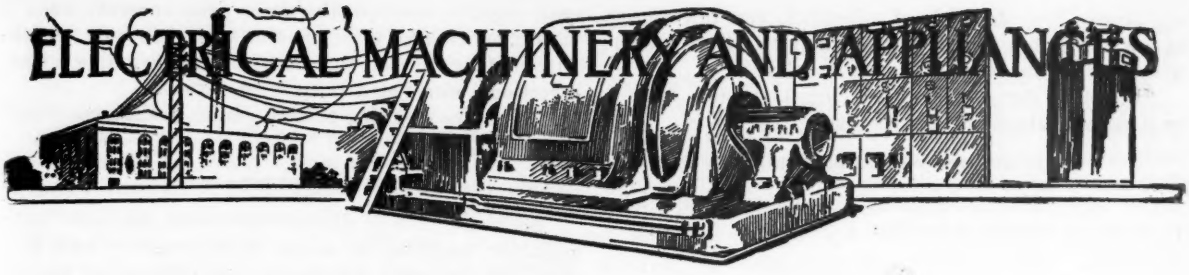
I put the tel in the telephone,
Yet don't listen to what you say;
But push along what message you will—
Near or far, by night or day.

From your slumber I often wake you
When times of emergency come.
Like a sentinel faithful at duty's call,
With bell clang or buzzer's hum.

I light your steps in the darkened way,
For your auto hot sparks I drive;
Light lamps for beauteous hall I make,
Nor fail while my power's alive.

You trust me in bank and mansion,
For I never pilfer or spy.
My only aim to do faithful work—
I'm a cell—just a battery dry.

—J. B. DILLON.



A Study of Dynamo Electric Machinery---X

ALTERNATING-CURRENT GENERATOR DETAILS; REGULATION OF MACHINES. BY OTTOMAR H. HENSCHEL

FROM a mechanical standpoint, an alternating-current generator may be one of three types, namely revolving armature, revolving field, or inductor. The first mentioned, as in the case of the ordinary direct-current generator, consists essentially of a stationary structure with inwardly projecting pole pieces, the

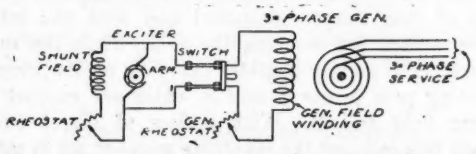


FIG. 67. DIAGRAM OF CONNECTIONS INDICATING MANNER OF EXCITING ALTERNATOR FIELD WINDINGS

field, and a revolving member, the armature, which, however, instead of being fitted with a commutator (except in the case of composite wound machines) is provided with two or more collector rings, the number depending upon the type of winding employed. Where this is such as to deliver single-phase current, but two

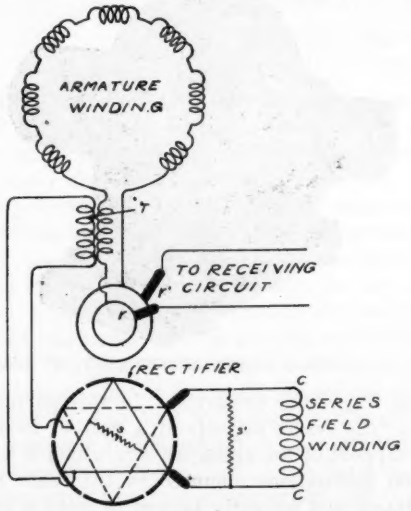


FIG. 68. DIAGRAM OF CONNECTIONS OF COMPOSITE WOUND ALTERNATOR

rings are used; where two-phase current, ordinarily four rings; while on three-phase machines at least three rings are required.

MAINTENANCE OF FIELD FLUX

IN DIRECT-CURRENT MACHINES, the field flux is created and maintained by the "excitation" of the windings by a part or all of the current being delivered (this depends upon the type of winding whether series, shunt or compound). However, in alternating-current work, the generator, as its name implies, delivers only alternating current, the characteristics of which do not adapt it to field excitation purposes, and, as a consequence some external source of direct current must be depended upon to provide the excitation required for the maintenance of the necessary voltage. Usually small direct-current generators, either direct-connected or separately driven, are employed, although in many instances storage

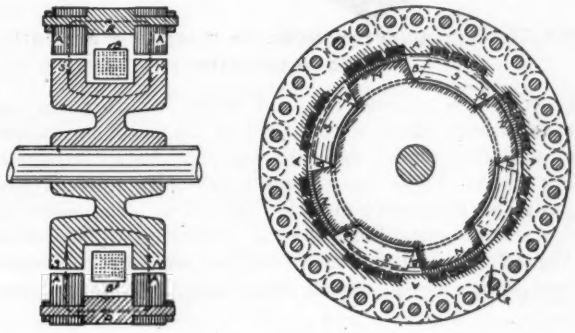


FIG. 69. SECTIONAL VIEW OF INDUCTOR ALTERNATOR

batteries are utilized, particularly for emergency service, as when for some reason or other the regular source of excitation fails.

In Fig. 67 is shown a diagram of connections, indicating the manner in which the field coils of an alternating-current generator are "excited." As the load on the alternator approaches maximum, the voltage on the outside lines decreases and in order to compensate for this drop, the alternator voltage must be raised. This is accomplished by cutting out some of the resistance of the alternator field rheostat, which allows an increased flow of current through the field winding. A rheostat is also inserted in the exciter field circuit in order to maintain its voltage at a constant value with varying loads; the greater the current flow through the alternator field winding, the greater the load upon the exciter.

Exciter capacity should usually be about ½ per cent of the alternator capacity for high-speed turbine-driven

machines. They should be of a design to give full voltage at low excitation, so that a small change in field current will cause an appreciable change in voltage.

Rheostats for exciter field circuits should have a resistance of about three times that of the fields.

Composite-Wound Machines

In some alternating-current generators, especially those of the smaller capacities, a portion of the current

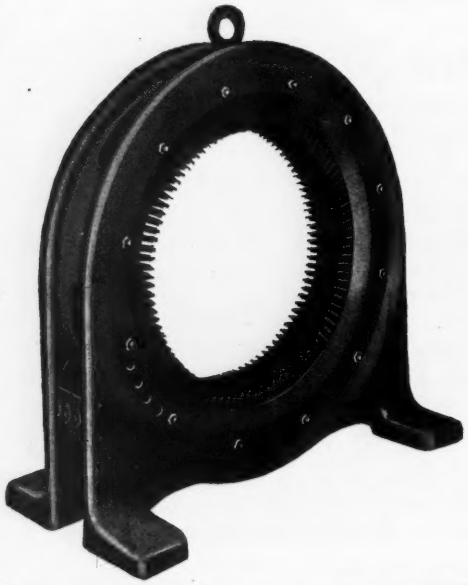


FIG. 70. STATIONARY MEMBER, OR STATOR, OF REVOLVING FIELD ALTERNATOR

generated is utilized for field excitation purposes, an arrangement which not only allows the use of an exciter of somewhat smaller capacity, but provides a compounding effect. These machines are generally termed composite or compound-wound alternators. The essential features of connections of such a machine are shown in Fig. 68. In addition to the regular winding, the armature shaft carries a small transformer, T, the primary

FIG. 71. SHAFT, REVOLVING FIELD CORE, POLE PIECE AND STEEL KEYS

of which is in series with the armature winding while the secondary is as indicated connected to a rectifier consisting of a commutator mounted on the armature shaft adjacent to the collector rings. The number of segments employed is the same as the number of field magnet poles with alternate segments interconnected and each set tied in with the transformer secondary in the manner indicated. With the brushes which bear against the segments of this rectifier given a spacing equal to that between the centers of any two adjacent segments, each negative electromotive force (and current) wave is caused to assume a positive value with the result that the current flow through the machine series winding is unidirectional although pulsating in nature.

To reduce sparking to a minimum, resistances S and S^1 are employed.

Inductor Alternators

Another type of alternating-current generator is the inductor machine, in which both armature and field windings are made stationary, thus eliminating the use of moving conductors and contact-making devices, such as collector rings and commutators and brushes. Sec-

FIG. 72. FIELD COIL IN VARIOUS STAGES OF CONSTRUCTION

tional views of a machine of this type are shown in Fig. 69. The structure supporting the armature winding is of ring shape, laminated and with the interior surface slotted for securing the coils, while the revolving member is simply a spider carrying on its periphery projecting pole pieces N and S which are excited by a circular field coil B. With a flow of direct current through this coil and the revolving member set in motion, a magnetic flux is established and with the sweeping of pole pieces N and S across the face of the armature winding an electromotive force is induced in the regular manner. But few inductor machines are in use today.

Structural Details

In the revolving-field alternator, the type in most general use, a stationary member or stator of the form

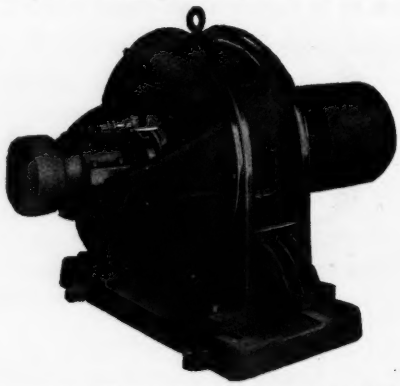


FIG. 73. TYPICAL 3-PHASE ALTERNATOR OF BELTED TYPE

shown in Fig. 70 is employed. In this particular construction, the frame consists of a pair of iron castings for the support of the armature core which is built up of sheet-iron laminations mounted in the inner periphery of the frame and properly lapped to make a practically continuous magnetic circuit. These laminations are secured by through bolts and are held in place by the clamping action of the frame castings.

Construction of the revolving field is shown in Figs. 72 and 73. Cores of the field poles are supported by a spider made up of sheet iron laminations and are built

up from punchings also of laminated steel assembled under pressure between malleable iron or steel end plates and are then riveted together.

On the pole cores is placed insulation over which the coils are wound. Collectors are bolted to a cast-iron ring pressed on the shaft, a form of construction insuring ample ventilation, high insulation and ready access. Armature coils are held in place by wooden wedges.

Some of these machines are fitted with individual exciters with armature mounted on the shaft carrying

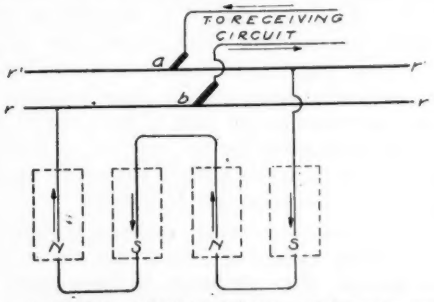


FIG. 74. A SIMPLE CONCENTRATED ARMATURE WINDING

the alternator rotating members; this provides against loss of excitation due to failure of the driving motor or engine.

Alternator Armature Windings

THE WINDINGS of alternating-current generator armatures are, as will be noted by the various diagrams of connections, much less complicated than those of direct-current machines, and may be either of the concentrated or distributed form. Where all of the wires on the armature are grouped in p slots, where p is the number of field magnet poles, the winding is said to be concentrated while with the wires spread out in p similar groups of slots, where p is again the number of field poles, the winding is termed distributed. As may be quite readily understood from a study of Fig. 74, which shows a simple and concentrated-winding, the electromotive force induced in such has a tendency to rise suddenly in value as the slots come under the pole pieces and to fall just as suddenly as the slots leave the pole pieces. This is, however, not the case with the distributed form of winding, for with this, due to the greater portion of

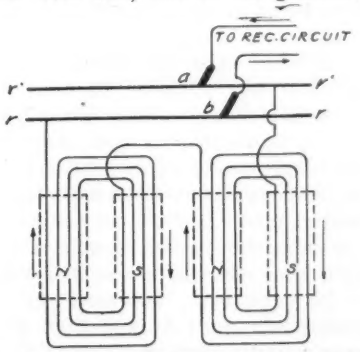


FIG. 75. SIMPLE DISTRIBUTED ARMATURE WINDING

periphery covered by each coil, the rise and fall of the electromotive force is more gradual.

Questions and Problems for Review

IF CALLED UPON to install a turbine-driven alternator of 5000-kw. capacity, what size exciter would you specify?

2. Make a rough sketch of an inductor alternator and explain its principle of operation.

3. What is a concentrated armature winding? A distributed winding?

Hydroelectric Power Collection

UTILIZING OTHERWISE WASTED ENERGY OF SMALL STREAMS BY USE OF TURBINE-DRIVEN INDUCTION GENERATORS. BY CHARLES P. STEINMETZ

IN hydro-electric plants, by far the largest part of the cost of installation is usually the hydraulic development, and by far the largest part of the cost of operation is usually the interest on the investment. Of our country's potential water powers only a small part can be economically developed by our present methods, since hydraulic power is rarely found so concentrated locally as to make it possible to bring together, in one generating station, a sufficiently large amount of power to have the value of this power pay for the cost of the hydraulic development required to collect the power in one place. A much larger amount of the country's water power may be developed by applying to electric power generation the same economic principles which have made the electric motor so successful. That is, to have individual electric generators wherever power exists, and collect the power electrically, just as economy requires to have individual electric motors wherever power is used, and distribute the power electrically. Thus, when it is economically not feasible to collect all the available water power by extensive and correspondingly expensive hydraulic works in one place and there locate one large generating station, smaller generators may be located along the water courses and throughout the water shed, wherever some power exists, and by a system of collecting lines—analogous to the distributing lines of motor application—the power of all these numerous generators collected in one system. These individual generators would be merely power producers, but the control of voltage, of frequency, etc., would be relegated to one large synchronous generator or synchronous motor station, possibly a steam turbine station acting at the same time as steam reserve on the system.

Electric generator and motor are identical machines, and if motor installations usually are very simple, comprising merely fuse and connecting switch, while generator installations contain an elaborate system of controlling and protective devices, the difference is not due to the nature of the machine and its function, but to the size of the installation. Thus very large synchronous installations also have a more elaborate system of operation and control, while the smaller generators used in electric power collection require no more elaborate appliances than a motor installation of the same size, that is, in the extreme case, merely a fuse to cut off in case of accident, and a switch to connect or disconnect. They

require no more attention than motor installations, that is, they can be left to run themselves without any attention beyond an occasional inspection.

In larger motor installations, the synchronous motor is preferably used and offers material advantages, except in those cases where specially heavy starting duty is required; but for smaller motor installations, the induction machine is exclusively used, due to its far greater simplicity, and thus reliability under these conditions. Thus also, in power collection by distributed generators, induction machines would be used for all but very large units, especially where—as would usually be the case with smaller installations—the generating station is to be operated without any attention beyond occasional inspection. The induction generator is the typical electric power generator applicable for these smaller stations; it is extremely simple, requiring no auxiliary appliances or machines as exciters; it converts into electric power whatever mechanical power it receives, and as long as it is connected to an electric system capable of receiving electric power, it does not attempt to, and cannot, control voltage or frequency, etc., but leaves all control to a central synchronous controlling station, as required in such a power collecting system.

Besides the advantage of simplicity, due to the absence of an exciter plant, perhaps the most important advantage of the induction generator over the synchronous generator, in a hydraulic plant, is that the induction generator cannot be damaged by overload, as it cannot be overloaded. The power output of the electric generator is limited by the maximum power which the hydraulic turbine or waterwheel can give. In the induction generator, current, voltage and power output are definitely and rigidly related to each other, and thus, with a given maximum power (that given by the waterwheel) the maximum current of the induction generator is limited and no excess current can occur. Not so, however, with the synchronous generator. With a given power output, the current in the synchronous machine feeding into a system varies with the excitation, and with wrong excitation a synchronous motor may be overloaded by excessive current, though its power output is below full load. Thus overload current protective devices, necessary in synchronous generators, are not needed in induction generators.

In its simplest form, such a power collecting unit, as located along mountain streams, etc., thus would comprise: A low dam across the creek, just high enough to raise the water sufficiently to cover the intake to the pipe line; a few hundred feet of city water pipe; some simple form of waterwheel, driving a low-voltage induction motor as generator; a step-up transformer connecting the induction machine with a medium voltage power collecting line, probably of a voltage between 10,000 and 30,000; a disconnecting switch between transformer and high voltage line; fuses between induction generator and transformer, to cut off in case of accident; to this may be added an integrating wattmeter, to keep record of the total power delivered by the unit.

Ammeters, voltmeters, wattmeters and frequency meters may be installed in larger stations, for the information of the inspector, for test, etc., but are of no use in operation, as neither current nor voltage nor frequency can be controlled in the induction generator station, but are controlled from the main synchronous station of the system.

As the hydro-electric induction generator cannot be overloaded in operation, the fuses between generator and transformer are for the purpose of cutting off in case the machine is held at rest under voltage, as would occur if the turbine were stopped by accident, such as by ice or other obstructions.

If the voltage comes off the line, the turbine races. The voltage then comes on again and temporarily large currents flow while pulling the speed down to normal. Not to cut off in this case, it is desirable to have time limit fuses, that is, fuses which do not blow instantly at excess current, but, due to the presence of a heat-storing element, only after some time, perhaps a minute or more. That is, such fuses as are used to some extent in induction motor installation for the purpose of cutting off if the motor is permanently stalled, but not to cut off under the temporary excess current of starting.

The disconnecting switch between transformer and high frequency collecting line is not really necessary, but in general it is desirable to have some absolute cutoff for use in case of inspection, testing, repair, etc.

Lightning protective devices may or may not be installed in the induction generator station, depending on the frequency with which lightning is met in the territory, the value of the station, etc., in similar manner as applies to distribution transformers; or lightning arresters may be distributed along the power collecting lines, as is sometimes done with distribution lines, or located at special strategic points, such as the crest of hills, etc.

In general, outdoor installation of apparatus would be used, though the induction generator, especially if large in size, may be housed under a shed.

A speed governor on the turbine appears unnecessary, as the speed cannot be varied by the governor, but is held by the frequency of the system to which the plant is connected, and the speed governor thus, by partly closing the gates, could only reduce the output and thus waste power. An excess speed cut-off may be used to limit the speed in case of the voltage coming off the line, to 10 or 20 per cent above synchronism. Temporarily, however, the turbine would probably run up to its free running speed anyway, before the gates are shut by the excess speed cut-off. Turbine and generator thus must be built to stand free running speed, and it therefore is simpler and preferable, at least in smaller installations, to omit also the excess speed cut-off, and let turbine and generator run up to free speed if the voltage comes off the line. As soon as voltage is again put on, the load pulls down the speed to normal. To be able to pull the induction generator down to normal speed, from free running speed, its speed-torque curve must be higher than that of the turbine, in the entire range above normal speed, otherwise the machine may be stalled at over-normal speed.

Turbine Operation

Depending on local conditions, various arrangements can be made in operating the hydraulic turbine:

Where the water supply is fairly steady and uniform, the simplest arrangement is to let the plant run continuously, taking whatever water is available up to the

maximum power of the turbine, and letting the surplus run over the dam.

Where, as is usually the case, there are considerable seasonable variations of the volume of water, but the variations occur fairly slowly, the simplest arrangement is the use of a turbine with several nozzles, and the inspector at his daily or weekly round opens or closes more nozzles, in accordance with the available water.

Where there is some water storage, as is often the case, either by a dam impounding at least several hours' supply of water, or in some reservoir back in the hills, the plant may be operated intermittently. Especially is this desirable, if power is more valuable at certain times of the day. A float then closes the circuit of a small motor when the water is high, and the motor opens the gate and thereby turns on the turbine. Inversely, when the water reaches its lowest level, the float closes the circuit of the motor with reversed phase rotation, the motor starts in reverse direction and closes the gate, and thus shuts off the water. Or, the motor may be permanently in circuit and open the gates and keep them open against a spring, until the float reaches its lowest position and cuts off the motor and the spring then closes the gates. If the power then comes off the line, the gates will automatically close until the power comes on again. This gate motor, connected to the power collecting line, starts and turns on the turbine, if the water level is high, and if there is voltage on the collecting line. Thus, if with such intermittent power it is desired to use the power during certain parts of the day, the power collecting line is switched off at the main control station when its power is not needed, and switched on when the power is desired. Thus, when the reservoir is filled and the float closes the motor switch during a part of the day when the power is not needed, the motor does not start until the power is needed and voltage is put on the collecting line at the main control station.

With such an arrangement of intermittent operation between the collecting line and the induction generator a centrifugal cut-in and reverse power cut-out relay is inserted. Thus, when the water gates are opened and the turbine started, as soon as its speed has reached a certain percentage above synchronism, the centrifugal relay connects the induction generator to the power collecting line; it then falls into step and delivers power. When the reservoir is emptied or the water gates closed, the induction machine would still revolve, as induction motor driving the turbine; but now the reverse power relay disconnects it from the power line and it comes to rest.

The same method of control by float is also usable to turn turbine nozzles on or off with the variation of the volume of water, where there is no storage by reservoir. In this case, the overflow of the dam is made narrow and deep, so that the level back of the dam varies appreciably. The float back of the dam then closes the next turbine nozzle, when in the lowest position, where the overflow nearly stops, and opens the next nozzle when the overflow has risen so much that the water flowing over it is ample to feed an additional nozzle.

In this case, where the creek does not run entirely dry, centrifugal cut-in and reverse power cut-out obviously are unnecessary, but one nozzle would always remain open.

In general, the induction generator installation finds its best place where there is a fair head but small volume of water, and thus a very simple arrangement of induction motor direct connected to impulse waterwheel can be used along creeks, mountain streams, etc.—General Electric Review.

A Big Job in Little Time

WINDINGS OF 3500-KW. BOOSTER ROTARY CONVERTER CHANGED WITHIN 85 HR. BY E. C. HAZIER

IT WAS desired to make some changes on a 3500-kw. booster rotary converter, which included removing all main shunt field poles and coils, all interpoles and coils, and booster poles and coils.

The work was allowed to be proceeded with only on condition that the machine be ready to go back into service at the expiration of 89 hr. In other words, the machine was to be turned over by the operating company, Saturday evening, as soon as load condition would permit its being taken out of service, which it was assumed would be about 6 p. m. and returned to them the following Tuesday, 7 a. m.

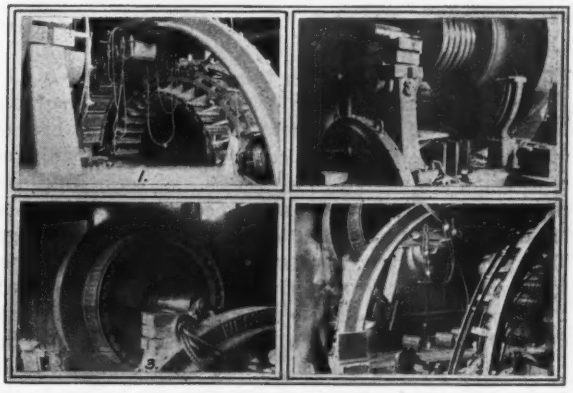


FIG. 1. PLACING MAIN AND BOOSTER COILS
FIG. 2. A. C. END AND BOOSTER
FIG. 3. PREPARING FOR REMOVAL OF LOWER POLE PIECES
FIG. 4. ILLUSTRATING CROWDED CONDITIONS UNDER WHICH WORK WAS CARRIED ON

This rotary is split horizontally and it was necessary to remove the top half of main rotary and top half of booster, and, of course, all brush rigging. It was also necessary to remove the armature from its bearings, as the lower half is set in a pit and the pole pieces could not be slipped out. The heaviest piece lifted was, of course, the armature, which weighs approximately 18 tons. This had to be handled with a hand-operated crane and due to lack of space in the sub-station, could not be laid aside. Therefore, it was blocked up on the pedestal far enough to allow pole pieces to be taken out of the bottom half.

This machine is provided with 32 poles, and after it was split, damper windings disconnected, connections between poles unsoldered, the poles were removed and taken to a press, coils pressed off and new coils pressed on, after adjusting considerable insulating washers and spacers. In addition to thus handling 96 pole pieces,

it was necessary to drill and tap four holes in each of 32 interpoles and bolt on an additional piece of iron to pole piece to accommodate the new coils. For this two drill presses were set up in the sub-station and started up early Saturday morning, and not stopped until Sunday night when drilling and tapping was completed.

Lack of space prevented laying the top half on its side for removal and replacement of pole pieces, and it was necessary to hoist each one of the 32 main poles and 32 interpoles into place with chain falls. Booster coils not being so heavy could be lifted out of and into place by hand.

The work was delayed about 6 hr. as it was necessary to unload and move into the sub-station a new rheostat weighing 3000 lb., this also having to be connected up along with booster field rheostat with new and heavier cable. A new and heavier field switch was installed, necessitating the pulling out of conduit all cable, and installing new field wiring.

At 3 a. m., Tuesday, 4 hr. before specified time, the rotary was all assembled and put on line and given full load of 14,000 amp. which it carried all day with good commutation.

Thirty men were used in making this change, 12 on each turn of 12 hr., with two men in charge of each turn and one man used as messenger.

There now is enough steel cable, clamps, etc., left over to lift a machine twice the size of this one, but why worry about a little thing like that when the machine went into service, all changes made 3 hr. ahead of time, with nobody expecting it to go into service until several hours, or perhaps days, after?

Another cause for rejoicing is because not a man was in any way injured, except perhaps his feelings, when he showed signs of slowing up at his work, and not a coil damaged or a reversed polarity encountered, and best of all, no tools were left in the machine to do damage when starting up.

The accompanying illustrations will give an idea of the magnitude of the work and also show the crowded condition under which this work was successfully handled.

The Failure of Condenser Tubes

Causes and Preventives

FAILURES of condenser tubes are chiefly due to (1) the splitting of the tubes, and (2) corrosion. Either of these failures produces a leak through which the injection water enters and mingles with the condensing steam, and as a result water containing corrosive and scale-forming substances may be pumped back into the boiler and cause considerable damage. This is not the only unpleasant result of tube failures, for in addition the defective tubes must be replaced, thus involving considerable expense; and unless the condensing apparatus at such a time is in duplicate, the plant must be run noncondensing until repairs can be made, with the possibility of injuring the boilers by the use of unsuitable water.

Fortunately, condenser tube failures, especially those restricted to certain well-defined localities, are comparatively infrequent elsewhere. In plants where sea water is used—and particularly in marine service where it is the only water available for condensing purposes—tube failures have long been recognized as presenting a serious problem. In the United States abundant supplies of fresh water are available in the majority of plants, and here there is little if any difficulty in connection with the tubes; but in other plants where salt water, or brackish water from estuaries or from saline wells, must be used, the trouble is likely to be more or less serious.

Although the splitting of condenser tubes while in service is a serious matter, it is possibly the least of the difficulties to be overcome. Tube failures of this type are often spoken of as age (or season) cracking, and are quite similar, at least in the results produced, to seam cracks in welded tubes. Splitting does not occur as frequently as some of the other types of tube failures, but nevertheless it has received a great deal of attention. Investigations seem to indicate that the chemical composition of the material used—including the impurities which are usually present—is not the real source of the difficulty; but rather that the heat treatment the tube receives in the course of manufacture is the most important consideration. In accordance with modern engineering practice the tubes are lightly annealed after the final drawing process, and since this treatment has been generally adopted the splitting of tubes has practically disappeared.

Unfortunately, corrosion is not so easily eliminated. Experience has shown that many factors enter into the production of a tube that will give comparatively long service, and of these the question of proper composition is very important.

In considering the various proportions of the metals to be used in the production of the alloy it must be kept in mind that a material is required which will withstand considerable manipulation during the manufacturing processes, as well as one which will best resist the corrosive action of the water. Attempts to determine theoretically the proportions of an alloy that will successfully meet both of these requirements have not been altogether successful, and as a result the composition of those tubes which have given good service in practice is usually reproduced.

An alloy consisting of 70 per cent copper, 29 per cent zinc and 1 per cent tin—commonly known as "admiralty mixture"—is possibly the most resistant to the corrosive action. A mixture consisting of 70 per cent copper, 28 per cent zinc and 2 per cent lead has been used to some extent in Great Britain. Alloys of copper and zinc containing various proportions of zinc; copper-nickel alloys containing 10, 15 and 20 per cent nickel, and copper-aluminum alloys containing 5 and 7.5 per cent aluminum have been tried, but these have not been entirely successful.

While tubes that have been manufactured in accordance with the best practice may not corrode as rapidly or as seriously as those that are selected with less

discrimination, they will not always remain entirely unaffected, and consequently precautionary measures of various kinds are necessary.

The usual forms of corrosion may be divided into three general classes, (1) general corrosion, (2) pitting and (3) dezincification. In general corrosion the copper and zinc are uniformly removed in approximately equal proportions, or, in other words, the metal is dissolved and carried away, resulting in a uniform thinning of the tubes over the greater part of their surfaces. Pitting is similar to general corrosion, except that the action is local or selective in character, resulting in the production of small cavities and holes. In dezincification the corrosion takes such a form that the zinc alone is removed, the copper remaining behind but becoming soft and spongy, so that it offers little resistance to pressure unless it is supported by a backing of solid metal. Dezincification and pitting are the more common of these types of corrosion—failure of tubes due to general corrosion being comparatively rare.

Erosion is closely allied to corrosion, and in many cases is almost as serious. It differs from corrosion in that it is a mechanical action, and wears rather than eats away the metal of the tube. Where condensing water contains sediment such as sand, or particles of coke or coal, there will be a tendency to wear away the internal surfaces of the tubes. A more or less serious

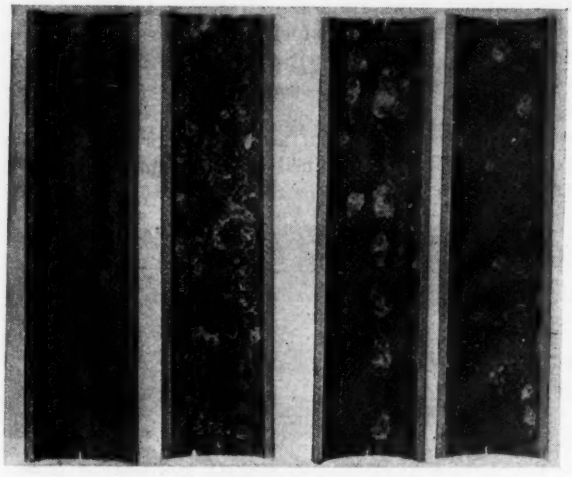


FIG. 1. CONDENSER TUBES FROM A SHORE STATION WHERE SALT WATER WAS USED

eroding action is also produced by the impinging of water or steam upon various portions of the tubes.

When erosion occurs the cause should be determined, if possible, and the proper remedy applied. If grit in the water is causing the trouble, suitable methods should be adopted to eliminate it. The installation of an efficient filtering system may be necessary, although in some plants this would be rather impracticable because of the large amount of water used. Locating the entrance of the intake pipe at some point where less grit will be encountered may afford a remedy.

The erosion produced by steam is not usually considered serious, and when trouble from this source is experienced it may often be entirely prevented by the use of suitable baffles. If the steam enters at a high velocity and wears away the upper rows of tubes, properly designed baffle plates should be installed. The use of such baffle plates will also reduce dezincification and general corrosion, as will be explained later.

The chemical action which is productive of general corrosion is rather complex in many cases. It is promoted by the oxygen in the air which may collect in certain portions of the condenser where eddies are formed, or where there is churning and foaming of the water. Inasmuch as erosion as well as corrosion may occur at these points, either one may be augmented by the other.

If general corrosion is active on the external surface (or steam side) of the tubes, the use of baffle plates

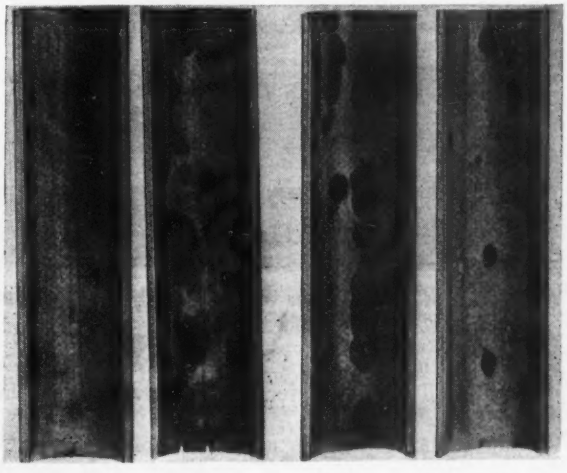


FIG. 2. TUBES SHOWN IN FIG. 1 AFTER REMOVING THE SCALE

—which was suggested to eliminate the erosive action of the steam—will reduce the formation of eddies at the ends of the condenser, and the consequent collection of air. If there is churning and foaming of the water where it enters the tubes this can be overcome by the use of screens or conical baffles—a smooth flow of water being assured by placing the points of the baffles over the openings of the tubes.

Dezincification may be found in any part of the tubes, but it occurs more frequently in the center where the tubes are hottest. The fact that pitting is also found in all parts of the tubes, and quite frequently near the bottom, lends color to the theory that contact of foreign bodies, such as particles of sand, coal or coke —and more especially the latter two, which are electronegative to brass—causes local corrosion or dezincification.

Dezincification is a phenomenon that is inherent in all brass alloys that are now commonly used in the manufacture of condenser tubes, and it appears to proceed more rapidly in connection with those alloys which contain the greatest proportion of zinc. Tests have shown that alloys of 70 per cent copper, 29 per cent zinc and 1 per cent tin, and of 70 per cent copper, 28 per cent zinc and 2 per cent lead are the most resistant to dezincification. The best of the ordinary alloys consist of 70 per cent copper and 30 per cent zinc, while Muntz metal—61 per cent copper and 39 per cent zinc —is the least desirable.

Temperature plays an important part in the dezincification of the brass alloys that are ordinarily used. This is shown by the fact that the effects of selective corrosion are usually most pronounced at the point where the tubes are exposed to the highest temperature. In condensers of the ordinary types this is at the center of the length of the upper row of tubes, directly in line with the steam inlet. When the corrosion occurs near the ends of the tubes it usually stops at the point where the tubes enter the tube plates, apparently because the temperature of the tubes is lowered at this place. Baffle plates should be placed to distribute the steam to all parts of the condenser. The temperature will then be equalized, and, in addition, the eddies at the ends of the condenser will be swept out. Increasing the speed of the water through the condenser tubes, preventing

FIG. 3. A CONDENSER TUBE WHICH FAILED AFTER 13 MO. SERVICE

choking by the use of screens and frequent cleaning of the tubes, all tend to lower the temperature and thus reduce selective corrosion.

Power plant operators often overlook the necessity for the frequent cleaning of condenser tubes, and the effect that scale has upon dezincification. The formation of an oxychloride salt of zinc is especially favored by the use of sea water. This compound produces a scale that appears to act as a catalyzer, freeing the chlorine from the salt contained in the water, which then quickly attacks the brass. Examination of the tube will reveal, in nearly every such case, a red blotch directly beneath the scale, showing the effects of dezincification. It may be impossible entirely to prevent dezincification by the removal of the scale, but frequent cleaning of the tubes will certainly lessen or retard the action, and in a good many plants there is great need of improved practice in this respect.

A method which promises to be of considerable value for protecting tubes against corrosion is electro-chemical in nature, and is based upon the theory that brass corrosion is mainly if not entirely electrolytic in character. Protection by electro-chemical means consists in the use of an electrical current to concentrate all of the corrosion upon some part of the condenser that can be easily and economically renewed. The measure of success attainable by this method is still to be determined; for although it has been found to be beneficial in some cases, in others no particular improvement has been noted. In view of the general interest in the subject a brief outline of the two methods commonly used will be given.

One method consists in establishing a flow of electricity by connecting the brass tubes with a block of some metal—such as zinc, iron or aluminum or one of its alloys, which is electro-negative to brass. By this arrangement the brass, which is to be protected, is made the cathode where hydrogen will be liberated, and the protector block, composed of metal which is electro-negative to brass, forms the anode where the oxygen is set free, and thus where the corrosion is concentrated. In respect to brass, zinc is more electro-negative than iron, and, at first thought, would appear to be a more suitable material for protector blocks. Iron is more commonly employed, however, because zinc becomes covered with a coating of oxide after a short period of use; and as the oxide is a poor conductor of electricity the protective value of the zinc is soon lost. Furthermore, the oxidation of the zinc proceeds more rapidly than would appear to be warranted by the conditions under which it is used, and the substitution of a material less expensive than zinc is therefore desirable. The iron is usually in the form of slabs which are placed in the water-ends of the condenser, and which are attached to the tube-plates by bolts. The connections must be very substantial so that they will not be broken by rust, or in any other manner which would destroy the electrical contact.

The second method is known as the Cumberland system of protection, and consists in placing iron electrodes in the water-ends of the condenser and connecting them to the positive pole of a direct-current dynamo. The iron electrodes are insulated from the vessel to which the negative pole of the dynamo has been connected, so that current flows from the electrodes to the walls of the tubes. A pressure of eight volts has usually been found to be sufficient, with a current density of two amperes to reach one thousand square feet of condensing surface. Oxygen is set free at the iron electrodes, and hydrogen on the surface of the tubes. The corrosion is therefore confined entirely to the iron electrodes, which can be replaced at small cost.

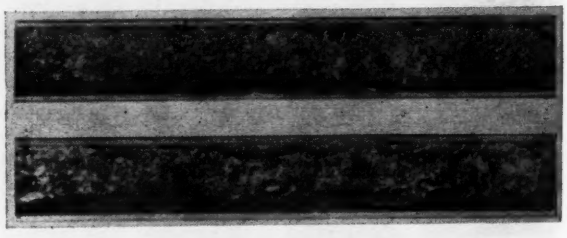


FIG. 4. THIS TUBE WAS IN SERVICE FOR NEARLY 3 YR.

There is at least one difficulty in connection with the electro-chemical methods of protection. In water containing considerable quantities of mineral matter in solution, various chemical compounds may be precipitated by the electrolytic action and deposited as a thin coating of scale on the inner surfaces of the tubes. This scale may serve as a protection for the tubes and thus prevent corrosion and dezincification, although it will retard somewhat the passage of the electrical current. Wherever this coating becomes scratched or broken, however, corrosion of the tube will usually start at once, particularly if the contact of the protector block is poor, and the electrical circuit is thereby broken.

In summarizing the causes of condenser tube corrosion it would appear that in many cases, at least, too little attention is paid to the conditions under which the condensers are used. The corrosive action is most

frequently due to the use of water containing acids, salts or solid matter, and while the production of a tube that will resist corrosion is desirable, it is most important also to consider means by which this action can be reduced. Under operating conditions the condenser should receive more attention than it ordinarily does. If the circulating water contains grit, or if the entering steam or water erodes the tubes, suitable precautions should be taken to prevent trouble from these sources. Install proper baffle plates to equalize the temperature in different parts of the condenser, and keep the temperature as low as possible. Clean the interior surfaces of the tubes frequently. These details are important if the corrosive action is to be reduced to a minimum.—The Travelers Standard.

The Seewer Pelton Wheel Regulator

REGULATION SECURED BY DIVERGING STREAM FROM NOZZLE. BY J. H. BLAKEY

FOR the past two years, M. Seewer has been experimenting upon a new form of regulator for Pelton wheels, at the Ecole Polytechnique at Zurich, Switzerland. M. Prasil, a professor at the school, and in charge of the experiments, writing in the Schweizerische

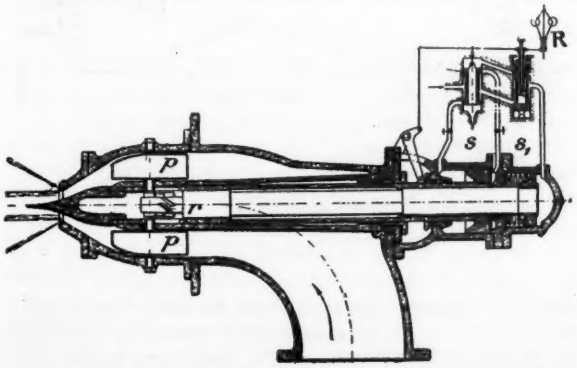


FIG. 1. SECTION THROUGH NOZZLE SHOWING ADJUSTABLE PALETTES

Bauzeitung, describes the perfected apparatus as a notable improvement upon the other forms of regulators now in use.

Instead of adopting the usual method of a nozzle movable about its axis, which can be shifted so as to throw a cylindrical jet against the buckets, either in a normal or an oblique direction; or the arrangement, equally common, in which a deflector is placed between the nozzle and the wheel, M. Seewer introduces into the nozzle a number of palettes p (Fig. 1) around the obturator needle. These palettes are capable of a small angular movement—not more than 20 deg.—upon their axes; which movement has the effect of transforming the cylindrical jet into a cone, more or less open as the divergence of the palettes with the axis of the nozzle is greater or less. The method of controlling this movement is shown in Fig. 1. R is a speed regulator or governor, which, when the speed of the wheel increases, acts upon the servo-motor* s_1; and also, but to a smaller extent, upon s. This action produces a flow of oil from each servo-motor into the obturator needle casing. The effect of the oil flow from s_1 is to advance the inner shaft within its sleeve, pressing the helicoidal grooves at r upon the axes of the palettes, which are thus turned out of the line of the nozzle axis. The resulting change in the form of the jet will produce an immediate slowing down of the speed of the wheel, because of the amount

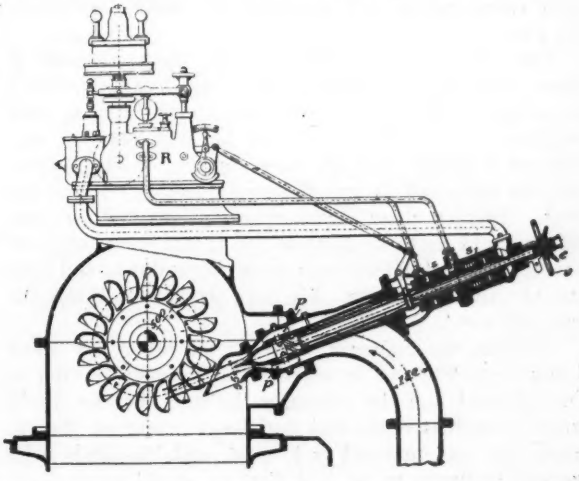


FIG. 2. PELTON NOZZLE EQUIPPED WITH SEEWER REGULATOR OF HAND OPERATED TYPE

of water deflected from the buckets by means of the deflector shown in Fig. 2. If, however, this is not sufficient, servo-motor s now comes into action, and the oil flow from this, acting upon the sleeve in which the inner grooved shaft moves, drives the obturator needle forward into the nozzle, thus slowly checking the flow of water. The advantage of this arrangement is readily seen, as making impossible a rapid movement of the needle, even with extreme increase of speed; thereby preventing sudden excesses of pressure and hammer blows in the supply pipe, which is generally under high pressure. A spring,

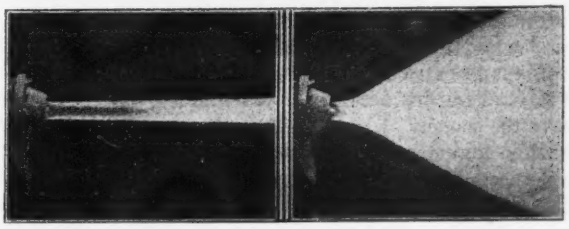


FIG. 3. VIEW OF JET FOR FULL LOAD OPERATION
FIG. 4. JET DIVERGED FOR REGULATING PURPOSES

shown in Fig. 1, causes the return of the inner grooved shaft when the oil pressure is released, and consequently the replacement of the palettes in their normal position. The experiments show that the movements of the palettes follow changes of the load on the wheel in approximately 1/10 sec., so that the control is practically instantaneous. The obturator needle can also be operated by hand by means of the hand-wheel v and the clutch e, Fig. 2.

LONDON FINANCIAL TIMES states that consumption of coal for marine purposes may be reduced to 50 per cent in two years by substitution of fuel oil.

*A servo-motor is defined as a motor whose movements are automatically controlled and follow the motions of the controlling apparatus.

Experiences at the Glendale Plant

BLAKE REPORTS THE ARRIVAL OF A NEW CHIEF ENGINEER; ALSO BADLY NEEDED VALVE SETTING. WALLACE REPLIES, GIVING THE NEWS FROM BRIDGETOWN. BY G. H. KIMBALL

DEAR WALLACE:

Your last letter was very interesting, and I see that your air compressors are giving more trouble than ours, but it will probably be easier to operate the plant.

Our new chief (?) commenced this week; his name is Jones and he came from some place near Graham's home town. He does not seem to be over familiar with engines; it is doubtful whether he ever handled any kind of a plant. We are now running the oil engine and we have had to run the steam engine part of the time. Talking about steam consumption: well! it was all we could do to keep steam for it last week, and our firemen left and Wilbur sent some others down, and they stayed only a few days. We have Graham to thank for that, all right.

Wilbur, the manager, came in the other day when I was on watch, and he asked about the men leaving so fast. I told him the reason, so he said that he would come down that night and try the indicator on the engine. He was on hand as he said, and the cards were something fierce, so he said that he would have to set the valve and that, as we were using the engine most of the day, he would come down after the cars came in at midnight.

At the time set he commenced work. It took most of the night, and he was not in a very pleasant frame of mind, so I did not interfere; but they must have been in pretty bad shape for him to be put out. He did not say anything to Jones as he went out; but he told me to see what she would do, so I put her on when the load came on and she worked far better than before.

The next day he was at the house as soon as I woke up. He told me to get into the car, and we went around looking for firemen and found two who would try it, so he told them to go right to work at the plant. You might wonder what Jones is doing all this time, but he told me that he was a watchman in a mill and has had no experience to speak of; from that, it seems that Graham just recommended him so that he could leave the sooner. I came in the other night and he had the big engine running without the condenser on, and he seemed to be utterly unmindful of what was going on. He has some good points, though, because he will not go about making adjustments and will do anything that you ask him to do; but he is not cut out for this job.

Wilbur is waking up now, and we have all the help that we need. I work a hundred hours some weeks, and I will just get home when they will send for me. The other day Wilbur offered the job to me; but I cannot take it, as I may have to leave on account of my family.

As the firemen are able to keep steam better now, we can keep them longer. I hope things are going better with you now. Good-bye for the present.

Your friend,

JOHN BLAKE.

ALBERT WALLACE REPLIES:

DEAR JOHN:

I can see that you are beginning to have your troubles and I know how to sympathize with you. I would naturally think that you would be the one to succeed to the chief's job, but it carries considerable responsibility with it that makes it less desirable to one situated as you are.

It has also been quite lively here for several days. When that paper gasket blew out the other night, we went down after supper to fix it, and one of Curley's new men came with me to help. He is full of enthusiasm and made the work much more pleasant. We found some asbestos paper that was much stronger than most, and it made a fine gasket for that head, which is rather a hard proposition to pack, as one side is hot and the other cold, so that the expansion of the head is unequal. It is surprising how hot air at 1100 lb. pressure is. I found that we shut down the whole system when we tried to start the compressor motor at six o'clock, and they did not know what happened to cause the trouble. Such accidents frequently happen in plants with an elec-

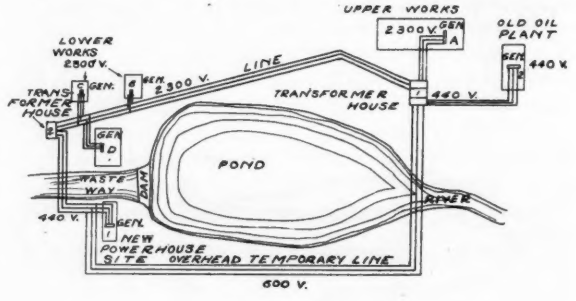


FIG. 1. PRESENT ARRANGEMENT OF THE WORKS AT BRIDGETOWN

trical system like this one has, for there are lines running in every direction, and some of them are overloaded.

Figure 1 is a general outline of the arrangement of the power system at present. I have not given you an idea of the number and size of the buildings, but only the location and the points where the power is generated and transformed into the proper potentials. Generator No. 1 has two vertical water wheels and a 150-hp. steam engine turning it; No. 2 generator is driven by an oil engine, as I have told you, and it is to be moved to the new power house. These two machines feed into the transformer house No. 1; A feeds into the primary side of transformers stepping down to 440 v., while generator No. 1 feeds into the secondary side for the power line. The lights are taken from transformers that step down the 2300-v. current to 110.

The upper works is a very large factory with some smaller buildings, and the line connecting with it on the same side of the pond is strung on poles and runs to transformer house No. 2 and is tapped into by the generators B, C and D. B and C are driven by water wheels and D by a large compound engine, and the same transformer arrangement prevails here as at the upper works.

Generator No. 1 is the one that I am operating now

and, while it is wound for 600 v., we run about 500 and tap into the 440-v. power line. The overhead temporary line is being put up now and will allow us to feed direct to the upper works power line while the new plant is being built.

Figure 2 is a general plan of the proposed arrangement when the new power house is completed, and you will see that generators A, B and C are not to be moved, since they will use what water power is available as at present, only they are to be rewound for 600 v., so that the primary voltage will be 600 from all machines, and the only transformers will be for lighting circuits. There will be three oil engine units in the new powerhouse and all of the boilers and pumps will be there also. The other steam plants will be cut out. From the power house, subways will be used as shown to conduct the pipes and wires to the factories, so that there will be very little overhead line.

The new arrangement ought to make the plant much simpler in operation, and if the work goes ahead as promised, everything ought to be running by this time next year.

I hope that things are improving at Glendale, for it is rather discouraging to work under those conditions. It means another new chief all right.

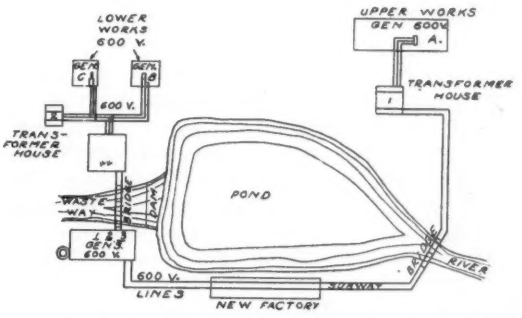


FIG. 2. PLAN OF THE PROPOSED ARRANGEMENT

Remember me to all of the boys.

Your friend,

ALBERT WALLACE.

Back Pressure on Compression Systems

BY A. G. SOLOMON

"I HAVE never thoroughly understood the factors which govern back pressure in a compression refrigerating system. All the books I have on the subject are more or less vague on this point, some stating that a certain back pressure should be carried to correspond with a certain room temperature. How do you do it? Is back pressure governed by the amount the expansion valve is open, upon the amount of liquid being evaporated by the pipe surface in the room, or by what? Is it possible to design a plant to carry any desired back pressure? A cooler 8 by 10 by 12 ft. is required to cool 8 beeves of average weight from 70 to 32 deg. F. in 24 hr. Insulation leaks about 3.5 B.t.u. per square foot per degree difference in temperature per 24 hr. What amount of 1¼-in. pipe for direct expansion should be installed? Could a back pressure of 25 lb., ammonia temperature, 12 deg. be carried?"

The above problem was recently put up to me and for the benefit of other engineers likewise perplexed I am anxious to present an extensive exposition of this important subject.

Whenever saturated ammonia vapor is considered, pressure and temperature are functions of each other, and cannot be separated. Just as soon as this relation is changed, the ammonia is no longer saturated vapor. Increase the pressure while the temperature remains constant, and the result is ammonia in a liquid state. Raise the temperature while holding the pressure constant, and a superheated gas will result.

By the foregoing statements, we see that the ammonia circulating through the parts of the system changes its state or form by the changing of pressure and temperature.

First, the ammonia condenser will be considered. The ammonia is delivered to the condenser in the form of a superheated gas. This is true even when a humid or wet compression machine is operated. Whenever the ammonia leaving the compressor is in the least saturated, the liquid contained in the vapor will cause pounding, as the clearance space between the piston and the compressor head is not sufficient to allow for the handling of any liquid.

The superheated gas is first cooled, by the circulating water, to the temperature of saturated ammonia vapor subjected to the pressure existing in the condenser.

To illustrate, we will take a plant where the condenser pressure carried is 195 lb. gage. This pressure corresponds to a saturated ammonia temperature of 98.9 deg. F. The ammonia gas discharged into this condenser must be lowered in temperature to 98.9 deg. before liquification is possible. In this case, it is readily seen that the temperature of the circulating water is not any higher than 98.9 deg. If the temperature of the water were any higher, the condenser pressure would be greater than 195 lb.

This pressure-temperature relation may be more readily understood if we consider water and steam instead of ammonia in its different states.

Water, in an open container, can be heated to a temperature of 212 deg. F. and still remain in the liquid state. If more heat is supplied, the temperature of the water is not raised, but its form is changed and steam at atmospheric pressure is the result. If it is desired to keep the water in a liquid state and still raise its temperature above 212 deg., pressure must be applied. Subjecting the water to pressure increases its boiling temperature. Likewise, increasing the pressure of ammonia increases its evaporating or boiling temperature.

The higher the pressure on both water and ammonia, the higher the temperature that is necessary to cause boiling. Every pound increase in pressure means a corresponding raise in temperature.

Just as long as the steam resulting from boiling water is not subjected to more heat, applied in some form of

superheater, the temperature of the steam and water remain the same. This steam is known as saturated steam and the degree of saturation (amount of moisture contained), does not affect the temperature. Now keep this fact in mind: Saturated ammonia vapor does not change its temperature when the degree of saturation is changed as long as the pressure remains constant.

Nobody ever has any trouble in thinking of the relation between pressure and temperature when water and steam are being discussed. Ammonia is just as easily understood if one will only give some study and thought to the table known as "Properties of Saturated Ammonia Vapor." Don't attempt to memorize this table, but just take a few of the pressures that are most common during the operation of the plant and fix in mind what temperatures correspond with them.

Now we will go back to the condenser. The condenser pressure will depend entirely on the temperature of the cooling water, provided that sufficient water is available. Shortage of water will have the same effect as would result from the use of a greater amount of water of a higher temperature. Of course, impure ammonia in the system will cause high pressure; but we are considering only the circulation of pure ammonia in a clean system. The overloading of the condenser by the handling of a superheated ammonia gas from the evaporating coils will be a plain reason for high condenser pressure. We will go into this more fully later on.

After superheat has been removed from the gas entering the condenser, the ammonia takes the saturated form and liquefaction begins. The superheat is generally entirely removed during the passage of the gas through the first two or three pipes of the condenser.

Continued contact of the saturated vapor with the cold circulating water causes the ever increasing degree of saturation till the point is reached where the ammonia assumes the liquid state.

After the ammonia is liquefied, it is cooled to the temperature of the circulating water. This cooling of the liquid is more complete and noticeable in the double-pipe condenser, as the coldest water comes in contact with the liquid leaving the condenser. In some types of the single-pipe condenser, the counter-current effect is realized to a great extent; but in the more common style of atmospheric condenser, the water is heated several degrees in its passage down over the coils. In all condensers, the liquid will have a temperature very little higher than that of the water with which it comes in contact at the liquid outlet. A thermometer should be inserted in the liquid line, close to the condenser, and it should be watched and the liquid temperature kept low as possible. A shortage of ammonia in the system will cause a high liquid temperature; so when it is noticed that the ammonia is leaving the condenser warmer than usual, it is a good idea to look to the amount of ammonia in the system. Never allow the liquid to get so low that it does not show at least 1/3 of the glass full on the liquid receiver.

If the liquid ammonia leaving the condenser is neither heated or cooled, by any outside agency, this is the temperature at which it will pass through the expansion valve and enter the evaporating coils.

Reheating the liquid occurs when the liquid lines are allowed to pass through a warm atmosphere or when the liquid receiver is located in a warm engine room. Avoid this overheating by proper arrangement of the pipe work and by locating the receiver in as cool a place as possible. Insulate the liquid lines and receiver if that will prevent reheating. Insulation will be found a paying investment in most cases.

Precooling of the liquid is as much to be desired as reheating to be avoided. Evaporation (heat absorbing) of the liquid is just the opposite of condensing. In condensing, the superheat of the gas must be removed and the ammonia reduced to the temperature of saturated vapor at condenser pressure before liquification begins. In evaporation, the temperature of the liquid must be lowered to the temperature of saturated vapor at the pressure in the evaporating coils before heat can flow into the ammonia. This fact shows the importance of having the liquid as cool as possible when it passes the expansion valve. Just as many heat units are required to lower the liquid temperature as there are degrees difference between the temperature of the liquid passing the expansion valve and the ammonia already in the evaporating coils. This extra work of cooling will mean the evaporation of about 15 per cent of the total amount of ammonia, and this work must be considered useless as far as actual results are concerned.

Now, using an ordinary plant for example, the liquid that passes the expansion valve has a temperature of 80 deg. F. The temperature of the brine in the ice tank is 16 deg. Before any heat can be absorbed by the ammonia which enters the coils, the heat in the ammonia itself must be removed.

To permit heat to flow from the 16 deg. brine into the ammonia in the coil there must be a difference in temperature. About 10 deg. difference gives the best results in a well balanced plant. In this case, it will mean that the ammonia in the coils must have a temperature of 6 deg. Now we look at the "Ammonia Tables" and see what pressure corresponds to a temperature of 6 deg. This we find to be 34.60 lb. absolute, which will be just about 20 lb., as shown on the back pressure gage. To get the full refrigerating effect, this temperature of 6 deg. must be maintained throughout the entire length of the coil. This means that enough ammonia must pass through the expansion valve so that the saturated state will still exist at the outlet of the coil. That this condition does actually exist can be positively known only by having a thermometer inserted in the suction line to which the coils connect. Watch this temperature and keep it as close to the temperature of saturated vapor as is possible.

The heat absorbing work is done entirely by the evaporation of liquid in the coil and it is therefore plainly reasonable that any part of the coil whose inner surface is not in contact with liquid is not doing its share of the work.

If the amount of ammonia that passes the expansion valve is all evaporated and turned into superheated gas by the time it has traveled half the length of the coil, it is evident that the last half of the coil is simply acting as pipe work to carry the heat laden gas to the compressor. If the thermometer at the outlet of the coil shows the temperature of saturated vapor at back pressure, every foot of coil surface will be doing its full

share of actual work. The amount of liquid contained in the vapor leaving the coils, however, can be greater than is necessary for the work that is being done. The thermometer will not show this excess of liquid. So to be sure that too much liquid is not being sent to the compressor in an unevaporated state, keep the temperature of the ammonia at the outlet of the coil about 1 deg. above the temperature of the saturated vapor that corresponds with the back pressure carried.

The overloading of the condenser (mentioned before) is caused by sending more heat units to the condenser than the cooling water is able to remove. This happens when the temperature of the brine or atmosphere surrounding the evaporating coils is high, and a correspondingly high back pressure is being carried. During such times, the coils are not supplied with enough ammonia to have saturated vapor the whole length of the coil. If that much liquid were allowed to pass through the expansion valve, the back pressure would be so high that it would be almost impossible, owing to heavy load, to keep the machine running.

This will make it clear that not all superheated ammonia gas is necessarily discharged from the compressor, nor is it always subjected to high pressure. Ammonia vapor becomes a superheated gas just as soon as sufficient heat is applied to cause evaporation of the liquid contained. Thus in an ice tank where the brine temperature is 16 deg. the ammonia at the outlet of the coils is superheated gas if its temperature is above 6 deg. while the back pressure is 20 lb. gage.

The back pressure carried on the evaporating coils is governed by the temperature of the brine or room in which the coils are placed. The ammonia in the coils must be in a saturated state so that it is capable of absorbing heat. To keep the ammonia in this state, it is necessary to maintain a pressure that corresponds with the temperature of the saturated ammonia vapor in the coil.

To provide for an effective flow of heat from the brine or atmosphere, the temperature of the ammonia in the coil must be at least 10 deg. lower than the substance surrounding the coil.

The higher the temperature of the brine or room containing the evaporating coils, the higher the back pressure that can be carried. When a number of rooms or brine tanks, having different temperatures, have their coils connected to one compressor through one suction line, the temperature of the coldest room or tank will determine what back pressure is to be carried.

A heavy deposit of ice or frost on direct expansion coils will interfere greatly with the proper heat transfer to the ammonia and this will result in the necessity of carrying a lower back pressure than is desired. In attempting to keep the pressure up, the amount of ammonia sent into the coil will be greater than can be evaporated. This heavily saturated ammonia will cause frosting back on the compressor more than is wanted for the best results. In extreme cases, it is almost impossible to carry any back pressure without danger of slugging the machine with liquid. Frost has such an injurious effect on the proper operation of the system that special attention must be given to its removal.

It is impossible to operate a plant and carry any desired back pressure unless the temperature of the rooms allows for the pressure decided on. If sharp freezers are being held at a temperature of zero, it will be impossible to carry a back pressure as high as 15 lb. gage, as at that pressure the temperature of the atmosphere surrounding the coils and the temperature of the ammonia in the coils will be the same, which will not allow for any heat exchange, and the room temperature will go up.

In operating a compressor where rooms are held at zero, a back pressure of not over 10 lb. should be carried. This pressure will give an ammonia temperature of very nearly 10 deg. below zero. With extra long coils and extra amount of coil surface the temperature difference can be reduced some, depending on the amount of produce being put in the storage rooms.

A cooler 8 by 10 by 12 ft. will contain exposed wall, ceiling and floor space totaling 592 sq. ft. With outside temperature 70 deg. F. and a cooler temperature of 32 deg., the temperature difference will be 38 deg. If the heat leakage through the insulation is 3.5 B.t.u. per square foot per degree temperature difference in 24 hr., the total amount of heat entering the room will be $592 \times 3.5 \times 38$, or 78,736 B.t.u. To this must be added 20 per cent for lights, the opening of doors and for workmen. Then the whole will amount to 94,483 B.t.u.

We will take 700 lb. as the average weight of the beeves. The 8 beeves will have a total weight of 5600 lb. The specific heat of beef is about 0.8. The beef is to be lowered from 70 to 32 deg. This will give a temperature reduction of 38 deg.

Now we have $5600 \times 0.8 \times 38$ which equals 170,240 B.t.u. the amount of heat to be removed from the beef during 24 hr. Adding 94,483 and 170,240 gives 264,723 B.t.u. This is the total number of heat units that will have to be taken up or absorbed by the ammonia in the evaporating coils.

The rate of heat transfer from the atmosphere of a cooler to the ammonia in a direct expansion coil will vary considerably depending on conditions which exist in different installations. In small rooms the air has very little circulation and the rate of heat transfer will not amount to more than 2 B.t.u. per hour for each degree difference in temperature for each square foot of pipe surface.

Now we know how many heat units are to be taken up in 24 hr. and we also know the rate at which the heat units will flow from the atmosphere of the room to the ammonia in the coil.

As it is desired to carry a back pressure of 25 lb., we will look at the ammonia tables and see what the temperature of saturated ammonia vapor is at that pressure. We find this to be just about 12 deg.

The next step is to decide on an average temperature for the cooler during the 24 hr. We will assume that the beef is all put in and the room closed up before the coil is turned on. In this case, the temperature of the room will be 70 deg. at the beginning of the 24 hr. At the end of 24 hr., the temperature is to be 32 deg.

As the temperature is lowered quickly when the coil is first put on, the average temperature of the room for the 24 hr. will be taken as 45 deg.

This average room temperature minus the temperature of the ammonia in the evaporating coil gives 33 deg.,

which is the temperature difference that we require to arrive at the solution of our problem.

At the rate of 2 B.t.u. per hour for each degree temperature difference, and a difference of 33 deg., we have a rate equal to 66 B.t.u. per square foot of pipe surface per hour. In 24 hr., this will equal 1584 B.t.u.

Dividing the total number of heat units to be taken up in 24 hr. by the number of heat units that flow through each square foot of pipe in 24 hr., we have 264,723 ÷ 1584 = 167 sq. ft. A square foot of 1¼-in. pipe is equal to 2.3 lineal feet. Then we have 384 ft. of 1¼-in. direct expansion coil for the room.

Just a little thought given to the amount of pipe and the size of the room will cause one to wonder at the way the coils are to be arranged. This problem is rather peculiar, as the room is small compared with the amount of heat units handled. Owing to the small room and the large amount of heat units, the ratio of piping to room space is about 2½ cu. ft. space to each running foot of pipe.

The pipe will have to be placed on the ceiling and on two side walls. The ammonia should be fed in at the bottom of one of the wall coils and the suction taken from the top of the other wall coil. The ammonia will pass through the ceiling coil after leaving the first wall coil and before entering the other. This arrangement is good and the results will also be all that can be desired.

A better arrangement for a beef cooler of this size and to handle the amount of beef will be to place the evaporating coils in a low ceiling pipe deck over the room containing the beef. Make the coils 7 ft. long, 6 pipes high and 6 pipes wide in the form of a bank. Space pipe not less than 6 in. centers. This gives 252 lineal feet of pipe.

Make three air shafts between the pipe deck and the cooler. The shaft in the center is for the passage of cold air downward and is built just even with the pipe deck floor. The other shafts are to allow the warm air to rise up from the cooler and they must extend up so that the top is even with the top of the coils. All three shafts should be 12 in. wide and extend the length of the room.

This arrangement of the coils and air shafts gives a good circulation and in that way increases the rate of heat transfer from 2 to a little less than 3 B.t.u.

Cranes*

SOME NOTES ON SAFE PRACTICE AND SAFETY DEVICES IN CONNECTION WITH OVERHEAD AND LOCOMOTIVE CRANES. BY CHESTER C. RAUSCH

THE locomotive crane is coming to be one of the most common types in use for coal handling, as it is not confined to definite limits of operation within a building or over a given yard space but, because of its mobility, it operates equally well within a shop or about a yard. This flexibility of operation considerably eliminates the number of times that a piece of equipment must be handled when it is taken from one location to another.

The locomotive crane is a rather recent development and while its hazards are more or less obvious, there are not as many men available who are skilful in handling this type of crane as there are of other types. One of the main sources of hazard consists in the failure to keep the road-bed over which the crane must travel in the best condition. Frequently, in an effort at economy, light weight or partly decayed sleepers and second-hand, defective or light rails have been used, resulting in an inconvenient and unsafe roadbed. The failure to keep the road bed properly tamped and drained allows it to settle and become uneven so that the crane does not travel steadily and is far more likely to overturn.

Overturnings are frequent with locomotive cranes. In the smaller sizes the wheel base is extremely short and in many cases the boom is swung with loads beyond the safe capacity for an increased angle of elevation and the crane is tipped on its side when this angle is increased ever so little as a result of even slight inequalities in the roadbed. Even when traveling on a straight track under these conditions and with the boom axis parallel to the axis of the track, slight obstructions on the rail are sufficient to cause disaster because the crane is working practically at its ultimate lifting capacity and its point of safe balance.

Inability to see toward the rear when the crane is moving forward frequently results in people being injured when the crane is turned on its table and inability to see toward the rear may cause people or objects to be run over when the crane moves in that direction. Reflecting mirrors, similar to those used on automobiles, tend to eliminate this difficulty, provided the mirrors are adjusted carefully and are of sufficient size to afford ample view. In some cranes small windows have been placed low down in the rear of the crane and the storage tanks and coal pockets altered to permit the use of peekholes through which the engineer, while standing in his usual place and turning his head, can see behind the crane.

Many times the original structure of the crane, particularly the boom, has been changed; lengthened to increase its range, strengthened to increase its capacity for lifting. Any lengthening of the boom immediately reduces the capacity of the crane to handle safety loads at a given elevation and an increase of the cable size and strength or an increase of the steam pressure to permit the lifting of heavier loads at greater boom elevations introduces strains that frequently cause collapse. The failure of many crane engineers to recognize the tremendous reduction in the safe capacity of the crane due to any change in elevation has resulted in the collapse of many booms.

Speeding the crane along the track, rotating the crane upon its turn-table at such speeds that the load is swung far beyond a point directly below the end of the boom, thus virtually increasing its length in addition to creating a considerable side strain and the dropping of loads from considerable heights and stopping them just before they reach the ground, are performances which the cranes were not constructed to stand, even

* Abstract of paper read before Eighth Annual Safety Congress of the National Safety Council.

considering all factors of safety used in its design. Where the crane is elevated upon a trestle the hazard is greatly increased because strains are sometimes thrown upon such a structure that it cannot safely withstand. There are several devices which have been attached to cranes to indicate when the crane is at the point of overturning and to give audible warning beforehand. The best devices of this sort are placed in the cab of the engineer and are frequently supplemented by an indicator placed on the boom, which shows, by means of a pointer, the safe load that may be picked up for any given boom elevation. This indicator may also indicate safe overhead clearances for the boom.

A pernicious tendency is sometimes revealed when the crane is derailed and a leverage action is created by attaching the boom to the track ahead and by the application of power causing it to lift the rear end of the crane so that it may be swung again to the rails. This is done with the boom in an almost horizontal position and has destroyed cranes by introducing the severest strains to which the crane could be subjected. The housing of the hoisting mechanism and the anchorages of the turn-table are very often torn apart in this manner.

One common fault with overhead traveling cranes is the failure to keep the rails upon which the overhead crane travels in proper line, both for lateral and vertical adjustments. A slight settling of the rails or a slight misalinement sidewise as a result of strains introduced by wind, settlement of building foundations, overloading of structural framework, etc., frequently causes the tracks to assume an extremely crooked appearance.

In many cases lighting fixtures arranged to furnish general illumination of the floor, are, from necessity, placed above the travel-way of the crane. If such buildings have wide spans the crane operator, unless properly shielded by an awning to his cab, is confronted in his view up and down and frequently across the shop with many spots of brilliant and glaring light that serve to confuse his vision. When operating the trolley on the far side of the shop these lamps throw a steady stream of light into the face of the operator, seriously confusing his action. Such lamps should be shielded from above with reference to any position the load to be observed by the crane operater must assume.

Many cranes have none of the electrical equipment in the cab properly guarded. There are exposed contact points, circuit breakers, knife switch and terminal lugs carrying from 110 to 500 v. or more. Contact with these exposed points may not only kill a crane operator but may temporarily incapacitate him so that his crane continues its motion uncontrolled. The use of the simplest forms of shields or guards composed of asbestos, wood, sheet metal or other materials are not only easily applied but inexpensive.

Many cranes have practically nothing more than a hand rail to keep the operator in the cab. During his slack moments, when he is comfortably stretched on a box, stool or bench, any lapse of consciousness would permit him to shoot under this rail and fall to the floor below.

Cranes, like all other apparatus, require occasional repairs and continual maintenance. An adequate repair deck should be provided over the crane which may be housed and from which oiling, adjustments and repairs may be safely performed. Many times repair men are exposed to serious hazards from falling on account of the lack of such a platform. It is not infrequently the case that the bottom chords of the roof trusses are used in making repairs and at such times they are subjected to strains which they were never designed to withstand.

Most cranes are now fitted with an over hoist or over travel stop that automatically arrests the upward travel of the hook and its load if the operator fails to disconnect the power of the hoisting motor as the hook-block approaches the hoisting drum. On large cranes that handle heavy loads the hook travel upward is slow and in many cases the part being hoisted requires a maximum upward travel of the hook. Crane operators have been observed to turn on the power and calmly wait for the load to come into contact with the over travel release, thus disconnecting the motor. The fallacy and danger of such operations are evident and should be matters of strict discipline.

Every crane requires its cable to be lubricated to prevent wear from friction and destruction from rust. While such lubrication accumulates grit and dirt in some shops the advantages of the lubrication tending to give long life to the cable more than offset the damage which this grit may do. The lubrication of the cables is sometimes accomplished by a man standing on the trolley, who applies the grease as the cable is wound up. Sometimes the cable is all wound up and the top half of the drum properly greased. The bottom half is then greased after the drum has made a half revolution to bring the ungreased cable into an upward position. The writer recently saw a very clever greasing device which could be temporarily attached to the top of the hoisting block in such a way that an arm holding collar made of soft wicking could project out and surround the cable. This arm was connected with a tank supplying grease in such a way that the cable, by passing through the collar, became properly lubricated throughout its entire length.

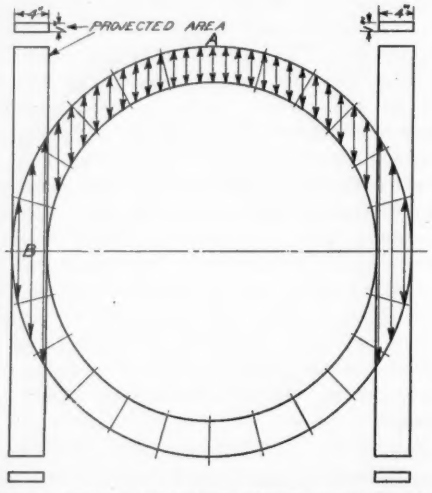
In view of the present knowledge concerning crane operation it seems rather trite to mention the fact that so many cranes are operated without a safe or convenient means of access to their cabs. The daily exposure of operators to falling, to contact with live wires, or to being overcome by fumes or gases while climbing to their cabs is considerable. It would seem the part of wisdom that not only new structures, but old structures as well, should be equipped with either a properly enclosed ladder or an adequate stairway from which the cab could be reached with a minimum of danger.

While the hazards created by the improper use of chains is well known, and may result in careful handling of them on the part of well informed operators, there are still a considerable number of floor men who introduce strains in crane hooks which it is impossible for them to stand without serious deformation or breaking. In handling some objects several chains are used so that the mouth of the hook is filled and attachments are made to the very tip of the hook in such a way that a severe side bending strain is introduced in addition to the lifting strains introduced by the chains hanging at the bottom of the hook.

Strength of Manning Boiler Firebox

On page 1077 of the Dec. 1, 1919, issue of Power Plant Engineering is a communication from I. B. Leavit in which he takes exception to my answer to question 6 published on page 887 of the Oct. 1 issue. This question read: How do you determine the bursting strain on the outer shell of a Manning boiler firebox?

As an answer, I gave: "Distance between the two sheets times boiler pressure." This, in the case of a boiler carrying 100 lb. pressure and with a 4-in. space in water leg, would be 4 times 100, or 400 lb., tending to burst each running inch of sheet.



SHOWING STRAIN ON OUTER SHEET OF WATER LEG

I might have said that I would multiply the projected area and the boiler pressure, which would be the same; for a 4-in. space, 400 lb., while for a 10-in. space it would be 1000 lb.

In the accompanying sketch the space between the projected area lines is balanced, which would not be if you had no stay bolts. Of course, stay bolts are put in to prevent the inner sheet from collapsing, but they also support the outer sheet, which gives a balanced leg, as the effective area would be the same in the balanced space as if you had two flat surfaces.

The pressure acts in straight lines out from the diameter, and at B there is nothing to support this space except the outer sheet, so we take the projected area of this space 1 in. long and multiply this by the pressure to give the pressure tending to burst the outer sheet. The greater the space between the two sheets, the greater is the bursting pressure, as you would have a greater projected area that the sheet must support.

If I had no stay bolts, the outer sheet would be figured as any cylindrical shell, for you would have the same effective area tending to tear the shell apart, and there would be no stay bolts to balance any part.

If you should use the radius, as you do in the barrel of the boiler, you would have to use a stronger joint on water leg. On the barrel of the Manning boilers of today a quadruple riveted double strap butt joint is used, while on the water leg outer sheet a double riveted double strap butt joint is used.

I am not surprised at Mr. Leavit's viewpoint, for I believed the same as he did for over 5 yr., and every time I went for examination they would not pass me. But at last I saw light and there is no question but that this is correct. I refer him to any manufacturer of water-leg boilers. W. N. L.

Review of Issue of Dec. 1, 1919

"Invoicing Your Ability" or "Taking Stock" as we might commonly call it, on page 1046, should be read about once each year by every engineer.

Every bookkeeper is expected to balance his books at certain times, generally at the end of each month. It would be well if each man made it a rule to strike a balance of his abilities and accomplishments each month.

Did you ever sit over there and look across the table at yourself, and subject yourself to an examination? Did you ever ask yourself such questions as: What are my weak points? In what way have I failed to do my part as another could have done it? Is my performance of my duties as thorough as it should be? Am I realizing the proper returns on the investments of thought and action? Have I applied myself to my duties to such extent that good returns should result?

Somebody has said that life is a savings bank and we draw interest on exactly what we put into it; the good deeds are the good coins, and those who perform their duties well will surely receive great returns on their investments, for good deeds always bring rich reward.

You, brother engineer, may compare your life and your actions to your boiler furnace, in this age of fuel conservation and high efficiencies; you may compare the hours and minutes you are on duty with the coal you use in the furnace; both are valuable and none should be wasted.

The slight neglects are as small leaks in the setting; a big loss in the long run. Just as the grates should be kept clean to permit the entrance of fresh air to create good combustion, so should your mind be kept clean and broad for the reception of new and valuable information that may aid you to better conditions in your plant.

And beware of the clinkers; you know the great trouble the furnace clinkers cause us. Well, the clinkers of our life are much worse, so you should prevent their accumulation by using for fuel the clean, up-to-date advice and instructions of your fellow men who are daily engaged in the same life work as you. So if you are operating at only half speed, it would be well to stop right where you are, clean fires and make a fresh start with a better draft and allow no air holes in your fire.

Application is the trade name for the elevator that has given many men their lift in life—it is not patented and you are permitted to use it as you will; "going up" all the time.

Under the subject of Fire Pumps, page 1047, there is information that every engineer should be very familiar with, for the fire pump in the plant is like the cowboy's pistol out West, "You don't need 'em often; but when you do, you need 'em darn quick." And the pump, like the pistol, should always be ready to do duty.

I was once engaged in a boiler plant that had no fire pump and no cold water pump. Sparks from the stacks frequently set fire to wooden structures about the plant. I made a hose attachment on a feed line of the boilers that was supplied by injectors and by proper regulation a splendid stream of water could be thrown by the use of the injectors.

We note that H. A. Cranford in his article "Protecting the Real Engineer with a Real License," believes that improvement should be the order of the age.

Now that the lap seam boiler is due to be retired by the up-to-date steam boiler regulations, Mr. Cranford also wishes to retire the single riveted lap seam engineer.

When the engineer of today stops reading the power plant papers and fails to attend the meetings of engineers, right then is when he begins to go backward; he doesn't even stand still but goes backward in the knowledge of his calling.

It is just like the remark we often hear, "you know I haven't done much figuring for several years and I have become quite rusty." To keep off the rust, it is necessary that you keep rubbing up against the other fellows in your line, either through the columns of the engineering papers or by attending meetings and by taking an active part in both you will become the brighter for it.

We all know that uniformity is a great base to build upon, and if we could have a uniform license law for the entire United States, it would prove a good step, for if an engineer can properly care for certain machinery in New York he could do likewise in Chicago; therefore his license for one location for certain machinery should serve him elsewhere.

Just like the good bookkeeper that gets the good salary because he is good at figures, the good engineer that is good at figures and keeps close record of all transactions in his plant will get the good salary.

I. B. Leavit.

Folly of Overloading Electrical Machinery

The article on the above subject in the Oct. 15 issue is timely and should be given serious consideration by operators who make a practice of overloading such machinery.

Some years ago I had charge of installing additional generating capacity in a medium-sized plant and, as the ordering of the new equipment had been delayed as long as possible, it developed that before the new unit could be installed, which was a 300-kw. turbine-driven generator set, the larger of the machines in use had to be operated for about 4 hr. out of the 24 at a very high overload.

This unit was an engine-driven 150-kw. set, the capacity being based on 80 per cent power factor. At about 6 p. m. the load would reach 150 kw., by 7 p. m., 200 kw., and by 8 p. m., 220 kw., where it would remain until 10 p. m., then gradually taper off. These conditions could not be avoided and lasted about two months, or until the new unit was put in regular service.

The generator in question had been in service about 5 yr., but had never previously been fully loaded. After the turbine unit was put in service, the engine set was used for the light-load period only; however, about one year later, while carrying about 50 kw., the machine developed trouble and before it could be taken off the line, the stator windings burned out.

Investigation showed that the insulation had been baked and charred to the extent that a break down was inevitable. The original damage was, of course, done the previous winter. The cost of putting this machine in shape to operate again and the loss due to higher steam consumption per kilowatt-hour during the light load period, by having this unit out of commission, was considerable and could have been avoided by placing the order for the new unit 6 mo. earlier than was done.

Theoretically it may seem nice to operate such machinery above rating; but for the man who pays the bills, it represents nothing but loss in the end. Obviously this practice should be discouraged.

C. T. Baker.

Steam Pipe Expansion and Other Things

In looking over Power Plant Engineering for Nov. 15 I notice several articles on which I wish to comment.

On page 1032 F. W. K. asks about expansion of steam lines. There is nothing in steam engineering that

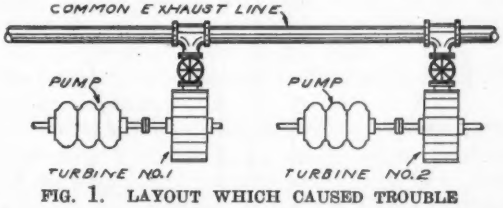


FIG. 1. LAYOUT WHICH CAUSED TROUBLE

requires the thought and study that expansion does.

One installation of pumps in one of the vessels built during the war gave all kinds of trouble. They were of the turbine variety and that, of itself, was enough to condemn them in the eyes of some of the old salts; the fault, however, was not with the apparatus, but with the manner in which it was installed.

Figure 1 shows the layout of the equipment. Whichever pump was started first had trouble with the flexible coupling pushing away from the exhaust pipe on the steam end.

The exhaust pipe was anchored in such a way that it could not push away from the turbine, so the turbine

pushed away from the exhaust pipe, causing distress in the coupling. This was remedied by a change of piping.

I erected a 12-in. auxiliary apparatus exhaust line and had trouble with flanges breaking. We are always admonished to turn on steam gently, so as not to break anything. The slower steam was turned into this line the more breakage occurred. The line was laid out as in Fig. 2.

When steam was turned on the pipe would lift from its hangers, as in Fig. 3A, the top heating first and expanding, while the bottom was still cold. If we attempted to tie the line down and not let it lift the

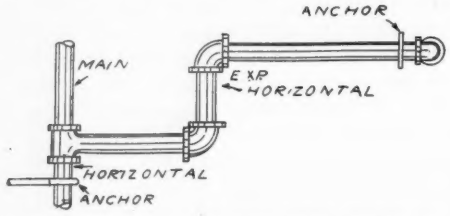


FIG. 2. AUXILIARY EXHAUST WITH PROVISION FOR EXPANSION

result was as in Fig. 3B. The bolts held the flanges together at the bottom and of course the flanges broke. Here was a case where heavy fittings had to be used on low pressure work and steam had to be let in quickly to heat the pipe all over at once.

John Thorn, on page 1027, offers good advice. I would rather have a good circulation in the blowoff pipe without covering than no circulation with covering.

Now, I would like to say a word or two on the editorial, "The Price of Success and of Failure."

Is the chance for success in the man's grasp who supports a widowed mother and five children, works

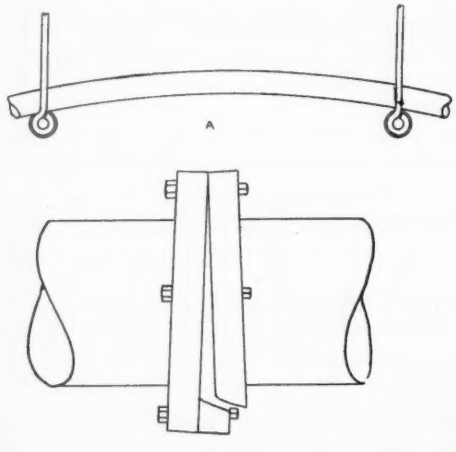


FIG. 3. A CURVATURE OF PIPE DUE TO EXPANSION OF UPPER PORTION. B RESULT WHEN PIPE WAS ANCHORED

twelve hours a day, doing practically two men's work? Is he able to take a technical course and get by?

I started when a boy of 14 and apprenticed to a mill engineer. I worked when the other boys were out playing. Was it a sacrifice, do you think? No, sir; I did it because it was more pleasure to me to be around a steam plant than it was to be out with the boys. I knew other boys who would have liked to do as I was doing, but they did not get the chance. Then when I was older and pushing a shovel 12 hr. a day, 7 days a week, do you think I had ambitions for a technical course?

Finally, I got a small engine, but even then I knew fellows who were just as much entitled to the berth as myself.

I can't believe that opportunity knocks at every man's door, even though some people insist on saying so. Perhaps it does knock when he is asleep.

After years I landed a position as chief in a plant of several thousand horsepower, though even then I could think of men just as much entitled to such a berth as myself.

Ask the real honest chief if he believes in luck and see if he doesn't say "yes."

TOM THUMB.

Use of Exhaust Steam

I HAVE been reading with much interest W. H. Davenport's "Exhaust Steam Required for Feed Water Heating," appearing in the Oct. 15 issue of Power Plant Engineering. In plants strictly for the generation of electricity for commercial sale, it is a rather fussy problem at times to know just how many auxiliaries to run by steam and how many to operate by electricity. It is a question at times whether the hot well (if there is one) should be carried at a slightly higher temperature so that the exhaust from auxiliaries will be sufficient, or whether the steam consumption on the main unit at a possibly lower vacuum will exceed the saving of a higher feed water temperature.

A difference of one inch in vacuum today means more than a few inches did some years ago, so we hesitate, as it were, to drop the vacuum to raise the hot well.

In this particular case the old saw, "He who hesitates is lost," is not exactly a wise saying, for it's a wise move to hesitate when it comes to dropping voluntarily the vacuum on a turbine.

Suppose the condensing apparatus (of the jet type) takes 1½ per cent of power of the main unit and the feed pump ¾ of one per cent.

I know from experience that in a moderate plant of a few hundreds of horsepower, perhaps, these figures are small; but in a large plant they probably obtain. For instance, in a plant of 12,500 kv.a., allow 250 hp. on turbine of condenser and 100 hp. on feed pump, though, no doubt, the turbine will be rated at 200 b. hp. and the condenser turbine at 400 hp. Here is 350 hp. in high-pressure turbines being used at a steam consumption of perhaps 50 lb. per horsepower, or 17,500 lb. of steam per hour.

If the turbine is working at 80 per cent power factor and loaded to 14,000 hp. at 12 lb. steam per horsepower-hour, 168,000 lb. of water have got to be heated for the main unit alone per hour.

If the discharge from the condenser should equal 80 deg. F., then theoretically we have enough exhaust from these two auxiliaries to heat the water about 100 deg. more.

As a matter of fact, these two pieces of machinery in an open heater will just about do this if steam is not

being wasted around the plant and the feed line is not supplying a tube cleaner.

Now if an economizer is being used, it is not necessary to heat the feed water over 90 deg. F., so, of course, there will be too much exhaust steam and the auxiliaries can be motor-driven or operated condensing.

The problem of exhaust steam about a manufacturing plant is a different proposition.

At one plant I had an output of 4000 hp. in engine and the auxiliary machinery was driven by steam turbines aggregating 1500 hp. This was a coal-burning plant and the demand for additional live steam in the process was startling, yet it would have been a losing proposition to run the main unit noncondensing, even though it could develop the necessary power, which it could not.

I am conversant with a textile plant that operates several units condensing and other units noncondensing. The water from the condensers is used in the process and not one drop goes to waste.

Several water wheels are operated, and if the noncondensing units make a surplus of exhaust steam, more water power is applied to that end of the plant and some taken from the condensing units, as it is cheaper to make a compound condensing horsepower than a free-exhaust-to-the-atmosphere horsepower.

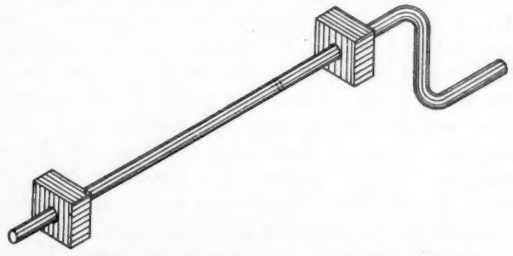
As a limited amount of water is available, this power is juggled from one unit to another to make an efficient running plant.

Heaters of several types using exhaust steam are in service at this plant, as well as economizers, and the waste is really very small.

Exhaust steam, whether used for feed water heating or other purposes, is economy so long as it does not go free to the air. TOM THUMB.

Review of Issue of Nov. 15, 1919

ON PAGE 1027, John Thorn treats the subject of blowoff pipes in return tubular boilers quite well, and his advice at the end of the article is proper, but he could have added to it, "and be sure to blow down the boiler at regular periods, and frequently enough to prevent scale accumulations in the pipe."



ANOTHER HANDY COIL SPRING WINDER

The use of the circulating pipe is, without doubt, of some benefit; but if the feed water contained much scale-forming matter and the blowoff valve was not used frequently enough, scale would have formed in the pipe.

There are more blowoff pipe accidents than most engineers realize. I was visiting a small power plant several years ago, in which three return-tubular boilers were being operated at 80 lb. pressure. While being shown about, the engineer pulled open the clean out door in the rear wall of the setting. The vertical section of the blowoff pipe was red-hot over about 2 ft. of its length, from the boiler downward.

Let me add right here that I was in the doorway of that plant in less time than I have written these last 25 words. The engineer pulled out the fire at once and cut out the boiler. The next day he made an examination and found the blowoff pipe slightly bulged where it had been overheated. The protecting brickwork that had been in front of the pipe had been knocked down while cleaning out the combustion chamber and they had failed to replace it. The boiler contained much heavy scale and did not receive proper cleaning.

The blowoff pipe contained some scale, not unusually heavy, but it was found that the pipe was filled with loose scale and there was a great quantity of loose scale packed tight over the blowoff opening.

I shall be perfectly satisfied never to see such a sight again, for I figure we were about rubbing noses with the Grim Reaper when we looked in on that red hot blowoff pipe.

Blowoff pipes should be protected by a V-shaped brick-pier, open at the rear end to permit examination of the pipe when desired.

If blowoff pipes are properly protected from the impinging flame and the boilers are kept free of loose scale by proper cleaning and blown down frequently enough to prevent accumulations in the boiler and blowoff pipes, there should be no difficulty with these pipes.

Blowoff pipes for all power boilers should be extra heavy and have ample thread to insure good connections.

No rule for blowing down boilers can be given that will prove proper for all kinds of feed water. I have visited plants where all boilers were blown out regular every 3 hr. for the entire 24 hr. of each day, and still contained much sediment and scale.

I have also visited plants where blowoff valves were opened only once every third day, and the boilers were practically clean internally.

With reference to water column connections, I have seen the lower pipes of water columns scaled to such extent that the end of a match placed in the opening that remained would close it entirely.

I once saw a lower column connection entirely closed by mud. A hole was burned in the bottom of the boiler, and when the boiler inspector arrived at the plant there was still one gage of water in the glass.

The foregoing conditions were the results of not blowing out the columns.

The lower water column connections should have a blow-out valve of ½ or ¾ in. connected to the lowest part of the piping, and not only under the column chamber, as many are arranged; if there is a long riser pipe, or considerable pipe between the boiler and column, then the column drain when opened will not draw out the sediment from this pipe, and for this reason there should always be a blow-down valve connected at the low point, and the opening of this will clear the pipe between the boiler and valve as well as the pipe between the column and valve.

A safe and simple rule that might be added to the article, Standard Practice for Tightening Bolts, by Mr. Rose, would be to remember Uncle Sam's instruction for the eligibles to war service: "Treat 'em all alike, and permit no slackers."

The burden of the slack bolt falls upon its neighbors, just as part of the neglected work of the sluggard in the power plant falls upon some of his fellow workmen.

The master mechanic of a railroad terminal once walked into the round house at noon time and found a number of engineers and machinists about the stove discussing what they considered the most important parts of a locomotive. He asked them which was the most important bolt on a locomotive. They made many replies, none of which was to his satisfaction.

Finally they asked him to inform them which was the most important bolt in a locomotive. He replied: "The loose bolt; that should be tightened."

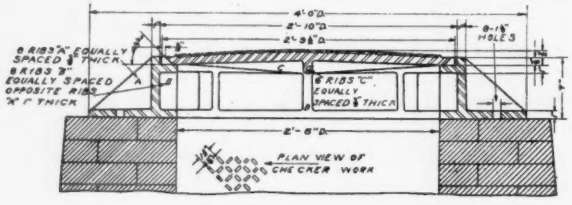
It would be well for engineers to remember that the loose bolt is the most important one and should receive attention.

The spring winder described by R. F. Mueller on page 1030 is quite serviceable. Another simple way of making coil springs is to have a rod bent as used by Mr. Mueller and have a small hole drilled through the rod as shown. Place two nuts in the bench vise, shove the rod through them, place the end of the spring wire in the hole in the rod and then turn the rod.

I. B. LEAVIT.

A Design for a 30-in. Manhole Cover

THE ILLUSTRATION shows a 30-in. diameter manhole cover, consisting of a cast steel frame weighing approximately 685 lb. and a cast steel cover plate, 260 lb. The frame is secured to the foundation by eight 7/8-in. foundation bolts.


8 RIBS "A" EQUALLY SPACED 1" THICK
8 RIBS "B" EQUALLY SPACED OPPOSITE RIBS "A" 1" THICK
8 RIBS "C" EQUALLY SPACED 1" THICK
8-1" HOLES
PLAN VIEW OF CHECKER WORK

SECTIONAL ELEVATION OF MANHOLE COVER

The drawing will be found explanatory, and complete dimensions are given in the sectional elevation to enable any pattern maker to construct patterns of the frame and cover as shown. GEO. W. CHILDS.

National Engineer's License Law

IN REGARD to H. A. Cranford's letter on Protecting the Real Engineer with a Real License, I would say that if engineers were rated in that manner, the majority of the employers would be looking for the 50, 60 and 75 per cent men.

If an employer has been experimenting with poor engineers and runs across a good man, the employer will, if he does not increase this employe's wages, try to make all he can out of him, knowing that he will leave the first chance he gets.

Then, also, there is a lot of difference between operating a big plant and a small one. In the large plant, you have up-to-date machinery and plenty of help; while in the small one, the chief has to stand a watch and maybe a 12-hr. one at that. In fact, if a 100 per cent man from a small plant would have a chance in a larger one, he would have easier sailing. But a 100 per cent man from the big plant going to a small one would 99 times out of 100 quit; I have seen it done many a time.

Some time ago, there was a 100 per cent man in charge of a big dredge boat; everything on it was up to date. For some reason, they laid up the big dredge and sent this engineer to an old one where things were old and run down; the crank on the main unit had to be run slack to keep it from heating up, and of course it would pound quite a bit.

They put the man previously in charge to operate the cutter engine. After starting up and running awhile, he took notice of the pound, and said: "Frank, you don't mind if I stop and take up on that crank?"

Frank said "No," for he knew well what was going to happen, and it wasn't 10 min. after starting up that smoke was rolling out the window from the crank.

From then on, that man fooled so much with that engine that he was pumping but 3 hr. out of the 10, and finally quit in disgust, whereupon the general superintendent told Frank to take charge again, and said, "That man may have been all right, but he was overestimated."

This way of obtaining results does not apply only to power plants, but to every line of work.

Brother engineers, there are many men in this world who get all the credit; at the same time, they are only riding on the waves of others. L. C. KAISER.

HAVING READ H. A. Cranford's article, I wish both to agree and to differ with him. To my mind, he is in the "right church but the wrong pew."

There is no question but that the Federal engineers' license would be the best thing that could possibly happen for both the engineer and the plant owner, but it would need to be supported by safe and sound boiler laws.

I have studied plants from Maine to Florida and the engineers and owners that would be benefited the most are those that are kicking hardest.

I want to start by dissecting Mr. Cranford's remarks about rating an engineer's license according to his ability. That cannot be done by any one license. These licenses are and should be granted for the protection of the life and property of the public and not for the benefit of the plant owner. The public is not interested to know whether an engineer can analyze coal, adjust a generator brush or figure his overhead or his coal consumption to the fraction of a pound a day. The question of executive ability and technical knowledge is of interest to the employer alone and should and could be separately licensed or covered by some diploma, although I am not interested in examining applicants for these honors. The man in this position would have fewer friends than a baseball umpire.

Mr. Cranford compares the engineer to the bookkeeper. It can't be done. A bookkeeper handles accounts which are only combinations of figures. They are either right or wrong. There is no middle ground as with engineering. What might be best in your plant might be decidedly wrong in mine.

The accountant's books can be balanced periodically, but an engineer's work never can be balanced. The only

way his employer can learn what he is doing is to study him, his problems and his methods. Encourage freedom of speech and confidence and feel that the engineer asking for an appropriation wants it for his employer's good and not for the sake of watching him squirm when he loosens up. The best way to get results is for the engineers to educate themselves and then their employers. Show them that engineering is a profession rather than a job.

I visit hundreds of plants every year and have been surprised at the things I have found. Some engineers know their plants thoroughly and keep them in the pink of condition, but are almost helpless when it comes to figuring efficiencies, seconding a motion in an association meeting or talking to the boss about matters pertaining to his plant. Others have chiefs that call the B.t.u. by their first names, can read a slide rule backwards, figure costs to four decimal places and yet could not start or stop one of their units or put in a new gage glass; yet they are all licensed.

To put the employers on the carpet, I will say that some think all engineers are a necessary evil forced on them by an unjust law. The cheaper man they get, the easier they have complied with the law (and cheated themselves as well). Other employers are broad minded enough to see that an engineer can waste or save many times his salary every year if given an opportunity, and treat him accordingly. I am glad to say that this class seems to be increasing.

While I believe in national license laws for the general uplift of the profession, the engineer is a composite made up of mechanic and business man and one license cannot cover both features any more than one license could cover the practice of law and medicine.

H. K. Wilson.

This subject, brought up is of vast importance, and interested me so much that I am submitting my opinion to the readers of this paper.

It is my belief that a license law should be as remote and distinct from the salary question as common sense will permit placing them. I am, however, in full accord with this article inasmuch as there is a great need, for the benefit of the general public, of a Federal License Law. The aim of this law should be to protect life and property and should be adhered to by 100 per cent. My interpretation (after taking some half dozen examinations) of the ability to pass examinations and consequently procure licenses is the possessing of ability to express one's knowledge; and anyone who has taken any examinations can verify this statement. Some can express thought more readily than others. Some have more practical ability and yet are unable to express their ideas, but it is the practical ability upon which depends the safety of life and property.

It has been my experience to note the distinct differences at the boundaries of districts included by license laws. Any engineer who has been required to engage men undoubtedly can recall how confidently a man can be engaged when he is the possessor of a license. If, however, the man has no license, it is up to the individual employer, whether proprietor or engineer, to put him to the test, so to speak, give him a license, or ability rating, for this particular job. This is not an easy task. It is also not uncommon to find that the salaries paid in a non-license locality far exceed those paid in license districts. A salary, differing very much from a license, depends upon the individual's ability to deliver the goods.

"Why are engineers not like bookkeepers?" They should be and the sooner engineers in general admit the fact and submit themselves to considerable inconvenience to learn and acquire bookkeeping methods, the sooner they will be graded. The reason an employer often adopts methods suggested by bookkeepers or accountants is: THEY TALK DOLLARS AND CENTS. That is just what the operating engineer should do when he addresses his superiors. The engineer must possess the ability to translate technical and engineering terms, about which most employers know nothing, into dollars and cents.

It must be borne in mind that manufacturers have organizations and by far stronger organizations than the different trade organizations, and that they hold luncheons and assemblages for the sole purpose of discussing production costs. Competitors are not fighting each other tooth and nail, but speak to each other the same as two engineers would speak to each other, discussing plans and problems.

With this one purpose in view, namely, to deliver the goods, every engineer should make it a point to read, not merely be a subscriber to, periodicals of a country-wide reputation. If it is beneficial for manufacturers to organize for the purpose of becoming better acquainted with the different methods of manufacture, etc., it is beyond a doubt an absolute necessity that individual engineers, if they are not already members of organizations, join at once. There is an organization which has for its sole purpose the idea of enacting engineers' license laws, for the protection of life and property and to educate its individual members to enable them to qualify for the so-called high salaried positions, but it must be borne in mind that the individual must possess ingenuity and initiative to put through problems that these organizations have threshed out for him. Knowledge is to the engineer much the same as the mechanic's tools are to the mechanic, of no value unless the owner knows how, when, and where to apply them. Walter J. Roehr.

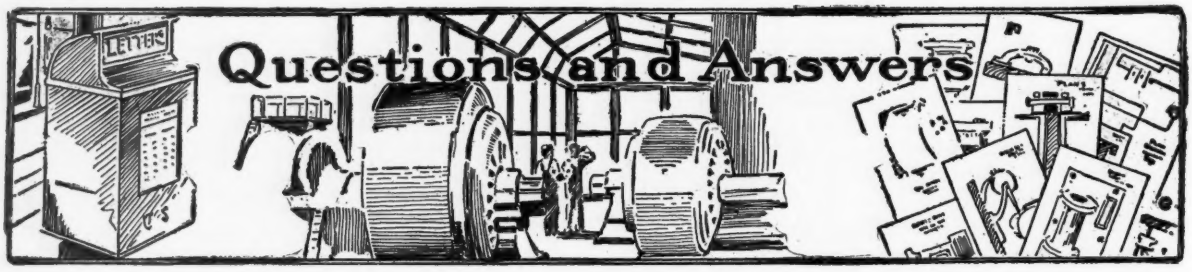
While H. A. Cranford has a very good plan, I suggest here another one.

I would suggest a grading along the lines of the government marine licenses. These grades are chief, first assistant, second assistant, and so on down for steamers of given tonnages.

Now, for power plant engineers, make it boiler horsepower. I say boiler horsepower, because in some plants we have engine turbines and ice machines, to say nothing of the auxiliaries. Have the licenses read as to class or chief, first, second, etc., of condensing or non-condensing steam-electric or steam-electric and refrigerating.

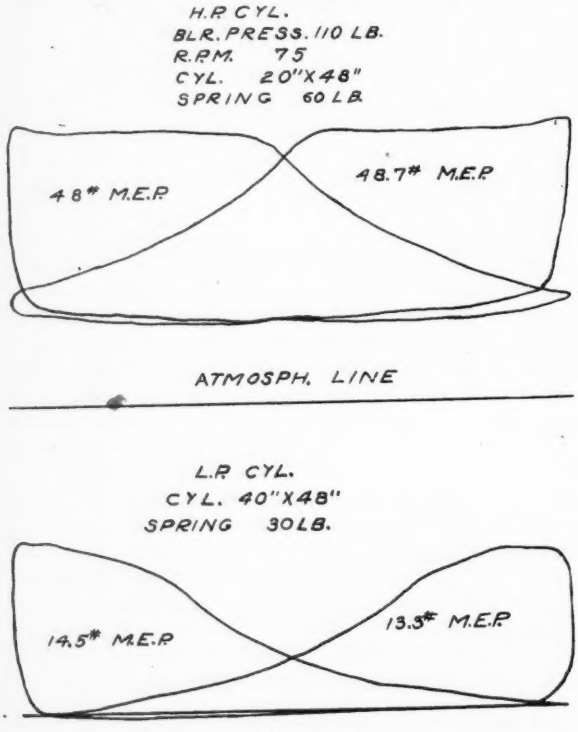
Here is another side of it: What about the young man just breaking into the game of power plant engineering? I am a young man not yet thirty, but have been lucky enough to get quite a variety of plants. A good many of the older heads say a man can't get anything from reading. I can't see it that way. Reading and studying have helped me and I believe, will help any man who goes at it as if he means business.

R. G. Summers.



Steam Engine Indicator Diagrams

THE DIAGRAMS herewith were taken from a 20 by 40 by 48-in. tandem compound Corliss engine which has been in operation day and night for 22 yr. Exhaust



DIAGRAMS OF 22-YEAR-OLD ENGINE

is used in a low-pressure turbine. What is wrong with them? J. A. G.

Exceptions to Examination Question Answers

ON PAGES 1077 and 1078 of the Dec. 1 issue of Power Plant Engineering, I. B. Leavit takes exception to some of the answers given to questions of W. N. L. as published on pages 886 and 887 of the Oct. 1 issue. I believe that to a certain extent W. N. L. was correct relative to the strains on the outer shell of the fire box of a Manning boiler. The strain on the outer sheets from the top row of stay bolts down depends on the sectional area between the sheets and the boiler pressure, and not on the radius. Above the top row of stay bolts, however, the radius must be used the same as in the calculations for a simple shell.

Answers to four other questions I think are wrong. In question 1, relative to finding the total bursting pressure along the longitudinal joint, he uses the radius instead of the diameter. The formula is (diameter × pressure) divided by (2 times the plate thickness) and for the girth seam use (area of head in square inches × pressure) divided by (3.1416 times thickness of metal).

With reference to answer to question 5: The radius is used in finding the bursting pressure in a boiler because the force tending to burst the shell in one direction is opposed by an equal force acting in the opposite direction.

Formula for finding receiver pressure answer to question 16 states "absolute initial pressure divided by ratio of cylinders." Where the steam pressure is 150 lb., the absolute pressure is equal to 150 plus 15, or 165 lb., and if the cylinder ratio is 4 to 1, the receiver pressure is equal to 165 divided by 4, or 41.25 lb. This is quite a high receiver pressure to carry; 15 lb. would be more like it.

As to the critical speed of a turbine, question 18, I should define this as the speed at which the shaft and rotor change from rotation about the geometrical center to rotation about the actual center of gravity.

JOHN J. BRESNAHAN.

Why the Short Stroke?

I WOULD LIKE some help from the readers of Power Plant Engineering. I have a 6 by 4 by 6-in. Fairbanks-Morse pump with 3-in. suction and 1¼-in. discharge placed 18 ft. below the boiler it feeds. One side of this pump operates smoothly, while the other side works with a jerky motion and causes a hammering in the feed line.

It is impossible for me to adjust the steam valves so as to overcome this action.

What is the remedy? P. W. M.

Heating an Office by Electricity

BEING INTERESTED in the electric heating problem appearing in a recent issue of Power Plant Engineering, I am offering the following solution:

The problem of calculating the power or watts to maintain a given temperature under specified circumstances, is attended with so many variables than an accurate calculation is quite impossible. Much depends on the location, the exposure to cold winds and various wall, floor and roof materials of various conductivities and radiation. Allowances must also be made for the number of people in the room and the frequency with which doors are opened and closed.

Assuming, however, a normal average installation with well constructed walls, tight fitting windows and doors, with no unusual conditions, the following formula may be used for preliminary approximate results:

$$\text{Watts} = \left(\frac{W}{4} + G + \frac{C}{55}\right)\frac{T}{3.4}$$

in which W = the exposed wall surface in square feet.
G = the exposed glass surface in square feet.
C = the contents in cubic feet.
T = the difference in outside and inside temp.

In the example given, as shown, the wall surface is about 4920 sq. ft., the exposed glass surface is about 840 sq. ft. (assuming 3 by 5-ft. windows), and the contents is 37,888 cu. ft.

Substituting these values in our formula gives the following:

$$\left(\frac{4920}{4} + 840 + \frac{37{,}888}{55}\right)\frac{44}{3.4} = \text{watts}$$

Solving this equation gives approximately 35.8 kw.

In making a more accurate calculation, the engineer must have tabulated results of the heat conductivity or losses of various walls and surfaces. The calculation is then made backward; that is, the watts or heat units lost by conduction, convection and radiation are calculated and, of course, this is equal to the watts or heat units which must be supplied to maintain a definite temperature. In other words, if heat units are liberated in an enclosed space at a definite rate, the temperature will rise to such a degree that the number of units escaping is equal to the number being liberated, this being possible due to the fact that the heat units escape faster and faster as the temperature rises, until a balance is established.

There are two calculations necessary: (1) the heat lost through the walls, floors and ceilings, and (2) the heat necessary to warm the air required for ventilation. Table I gives typical heat losses per square foot per degree, while Table II gives the cubic feet of air per hour for different buildings, a note further adding:

"These figures are for uncontaminated air. Where gas, gas illumination, etc., are present, additional provision must be made. A single gas burner consumes about 45 cu. ft. of air per minute. To heat one cubic foot of air one deg. F. requires 0.0054 w.-hr., or one kilowatt-hour will heat 2650 cu. ft. of air 70 deg. F. From this the energy necessary to heat the air required for ventilation may be readily determined."

Using these figures and recalculating our problem, we get the following results:

Exposed brick wall—
518 sq. ft. × 0.135 w. × 44 deg. = 3,075 w.
Wooden flooring—
2368 sq. ft. × 0.025 w. × 44 deg. = 2,604 w.
Wooden ceiling—
2368 sq. ft. × 0.03 w. × 44 deg. = 3,124 w.
Side walls, less openings—
2468 sq. ft. × 0.15 w. × 44 deg. = 16,280 w.
Doors—
84 sq. ft. × 0.17 w. × 44 deg. = 616 w.
8 small windows—
120 sq. ft. × 0.35 w. × 44 deg. = 3,168 w.
2 large windows—
720 sq. ft. × 0.3 w. × 44 deg. = 9,504 w.
Air required—
30 (people) × 1800 × 0.0054 × 44 deg. = 12,804 w.

Total = 51,175 w.

This calculation shows that the power required is about 50 kw. under normal circumstances. Of course this may have to be increased by the factors shown under the following table:

TABLE I. WATTS LOST BY RADIATION PER SQ. FT. OF SURFACE PER DEGREE F.

Radiating Surface	Watts Loss
Brick wall, 24-in.	0.0575
Brick wall, 12-in.	0.0925
Brick wall, 8-in.	0.1350
Brick wall, 4-in.	0.1930
Wooden flooring	0.0245
Wooden ceiling	0.0305
Fireproof flooring	0.0360
Fireproof ceiling	0.0425
Single window	0.3550
Single skylight	0.3000
Double window	0.1700
Double skylight	0.1850
Door (65 per cent wood, 35 per cent glass)	0.1700
Door (plain)	0.1200
Wooden partition 1 in. thick	0.1200

These coefficients will be increased as follows: Ten per cent for northern and windy exposure; 10 per cent where building is heated in daytime only and not exposed; 30 per cent where building is heated in daytime only and is exposed; and 50 per cent where building is heated intermittently during winter months.

TABLE II. AIR REQUIRED FOR VENTILATION

Service	Cu. Ft. Air Per Hr.
Hospitals	3600 per single bed
Legislature assembly halls	3600 per seat
Barracks, bedrooms and workshops	3000 per person
Schools and churches	2400 per person
Theatres and ordinary halls	2000 per seat
Office rooms	1800 per person
Dining rooms	1800 per person

If 10-kw. heaters can be purchased, it would be well to get five, placing two under each large window and one at the ends of the building. If 3-kw. heaters are used, it would be well to get about 17 and space them evenly around the room. The price of a 3-kw. three-heat heater is about $30.

With a little ingenuity a boiler could be arranged to heat water and use this to pipe the building for hot water or steam heating, and undoubtedly this would be considerably cheaper, although more or less of a makeshift.

The problem illustrates clearly the impracticability of heating buildings by electricity, due both to the cost of equipment and also current. At 10 cents per kilowatt-hour, this arrangement would cost $5 per hour to operate. It is not until current can be obtained at from 3 cents to 5 cents per kilowatt-hour that it can compete with gas at $1 to $1.50 per 1000 cu. ft. The main application for electrical heating is found where cost is a comparatively unimportant item as compared to convenience, as for instance on shipboard, street cars or sick-rooms, etc.

VICTOR H. TODD.

THE FELLOW who isn't fired with enthusiasm is apt to be fired.—Forbes Magazine.

Caring for Idle Boiler

WITH FURTHER REFERENCE to the question of W. C. H. on page 1085 of the Dec. 1 issue, I would like to offer the following suggestions relative to the means to employ preparatory to laying up a boiler.

After filling the boiler with water to within about one foot of the steam pipe connections, build a fire of damp straw or wood and tar and heat the water to from 150 to 170 deg. F.

Fill the boiler and then raise safety valve and pour in heavy machine oil to overflowing. After this, open blowoff valve sufficiently to allow enough water to escape to enable pouring through the safety valve opening another 3 or 4 gal. of oil.

Let the fire die down and close all drafts.

As soon as the water level shows in the gage glass, open top manhole plates and when sufficiently low remove the other plates.

The descending water level will cause the oil to cover the plate surfaces to which it will adhere upon cooling.

The wood and tar or straw and tar burned under the shell will form a deposit of tar on the outside plates.

Place a tray of quicklime inside the boiler.

R. G. SUMMERS.

What Causes the Knock?

IN THE Dec. 15 issue J. O. gives cards from an 18 by 42-in. engine at 104 r.p.m., carrying 80 lb. back pressure, and asks what causes the knock in the cylinder. These cards show that the engine is quite heavily loaded, cutting off at ½ stroke, but the 80 lb. back pressure is out of reason. To begin with, J. O. calls this engine a 450-hp., but how does he make it so? 18 by 42-in. and 104 r.p.m. has a horsepower constant of 5.6, which, multiplied by the government standard of 40 lb. m.e p., only makes it 224 hp. He is carrying 80 lb. back pressure, also mean average resistance, and this must be figured the same as m.e.p., except with the opposite effect, and it means $80 \times 5.6 = 448.0$ hp., which is resistance on the piston.

These cards show no compression, and while I am in favor of compression up to boiler pressure, I do not think J. O. will be able to carry much compression, because, while compression costs cutoff, although it saves coal in the end, he has no cutoff to spare. Without doubt, the knock he complains about is caused by the 80 lb. back pressure under the exhaust valve at the end of the stroke at a time when the terminal pressure is below that of the back pressure, as shown by the loop. The exhaust is raised off the seat and when it seats again causes the knock. If compression began where the lines cross each other it would stop the knock.

A. C. WALDRON.

THE QUESTION, "What Causes the Knock?" presented by J. O., brings up a chance for serious thought concerning the combination of bad conditions which he mentions. If it is necessary to carry 80 lb. back pressure to dry his beet pulp I am of the opinion that it would have been much cheaper, from the start, to have installed a smaller engine and run it condensing, and supply the steam to the driers through a reducing valve.

I wish that J. O. had drawn the atmospheric line on his diagrams, but we can tell pretty nearly where it would be by using a scale. I should say that it would help his case if he would move his exhaust eccentric ahead and obtain earlier compression and release. However, it may be advisable to leave the release alone and try earlier closing of the exhaust by adding lap and the later release so gained may be beneficial, also.

I would try to adjust my valves to produce a card similar to the ones we call good for the high-pressure cylinder of a multiple expansion engine, say a triple or quadruple expansion, which, of course, maintains a higher receiver pressure between the high and first intermediate cylinder.

There must be a gradual change from the exhaust to the initial pressure in any engine. There is really no compression in this case and I should expect that the bearings would have to be adjusted so closely as to prevent very hard trumping on centers that the friction would be so great that no amount of lubrication would keep them from melting out.

Another thing that may be necessary is a little more lead. It is plain to be seen that exhaust steam re-enters the cylinder when release takes place, due to the fact that the steam is expanded to a lower pressure than that of the exhaust and that must have a disastrous cooling effect upon the walls of the cylinder.

L. M. REED.

J. O. submits some interesting diagrams of an engine working against 80 lb. back pressure. He has a burned bearing about three times a year, or at least his predecessor had. I think if the engine had more compression, and an earlier steam lead, it would tend to run more quietly. When the exhaust valve opens the steam in the cylinder has expanded to a point where its pressure is lower than the back pressure, and a loop is formed, just like what occurs in an engine exhausting to atmosphere, and having a light load and high boiler pressure. As we try to avoid a loop thus formed, as being a loss of power, I would suggest that the boiler pressure be reduced further, and the action of the engine may be improved. When the boiler pressure was 200 lb. the chances are a large loop was formed.

I hope we may hear further from J. O.

TOM JONES.

Indicator Card Criticism

IN THE Dec. 15 issue appears a diagram submitted by G. B. for criticism.

G. B. states that his engine is noted for quiet running. It certainly ought to be, for an engine would have to be pretty loose jointed to pound with the amount of compression which the diagram shows; but from an economical standpoint I do not believe that he is getting good results with the present valve-setting. I would suggest that a little more lead be given, and that the compression be reduced about one-half, by reducing the lap on the exhaust valves. This will cause release to begin earlier, which I believe will also be beneficial in this case. Different engines, working under different conditions, will not always run with as little compression as would seem sufficient to insure quiet operation, and it is necessary for the operator to use pretty good judgment in regard to the amount of compression to allow on a particular engine. I believe, however, that G. P

will find he will get more satisfactory results if he will try my suggestion. While he may have to pay closer attention to the adjustment of his bearings, I believe that his diagrams will show a decrease in steam consumption according to the load carried.

L. M. REED.

REFERRING TO G. B.'s indicator card, if this engine has been running for 10 yr. without any valve adjustment whatever it has had good attention from the operating engineer in the matter of lubrication, both of the cylinder and valve gear.

The valve on the right hand diagram shows to be a bit late, caused by lost motion. The left hand diagram indicates that the steam valve is set nearly correct, although the compression is too high on this end of the cylinder. The compression should be reduced just a little on the other end of the cylinder also. Both of the exhaust valves are opening a shade too late.

G. B. will find that for a 14 by 36'-in. engine, which should run about 85 r.p.m., 100 lb. boiler pressure, ⅓ cutoff, should give him about 156 hp. with steam lap of 3/16-in., lead 1/32 in., exhaust lap 1/16 in., and a trial compression of 2½ in. H. W. ROSE.

THE INDICATOR cards submitted by G. B. show too much compression. The exhaust valves close so easily that it is considerably like placing a brake on the engine. I would advise G. B. to start in to cut down the compression as much as possible, consistent with smooth running of the engine. This may not be accomplished altogether with the valve rods; it may be necessary to set the eccentric back a little, also. If this is moved the steam valve rods will have to be changed; also the dashpot rods. Give the steam valves a little more lead.

TOM JONES.

Why the Stop in Flow

IN THE Nov. 15 issue, I read with interest, the letter of Perplexed Engineer, with drawing showing a water supply by gravity 5100 ft. long with a 41-ft. head, made up of 1500 ft. of 2-in. pipe and 3600 ft. of 1½-in. pipe. He wishes to know why he gets so small a flow and why it stops.

In the first place, he has only a maximum pressure of 17.75 lb. per square inch to force water 5100 ft. If this pipe were 2 in. the entire length, the friction would be almost great enough to stop the flow; with 1½ in. pipe, friction would be somewhat greater. I would suggest that this pipe be turned end for end, starting at reservoir with the 1½-in. pipe and ending with the 2-in. pipe at the mill, and made as nearly straight as possible. The air vents may be used on this line to good advantage, but the vertical leads should be eliminated as far as possible. In all installations of this kind, it should be borne in mind that vacuum must be considered, as water can be made to create its own vacuum. Water flowing in at a small opening under a given pressure and discharging through a larger opening has little or no friction, tends to create a vacuum, and intensifies the flow, while the same pressure entering the larger opening and discharging through the smaller one would increase friction and decrease flow, and the tendency towards forming a vacuum is eliminated. R. P. EVERENCE.

Boiler Pitting Difficulty

REFERRING TO F. I. F.'s account of pitting in his boilers, I would like to mention an experience I had on taking charge of the power plant of a big phosphate plant in South Carolina some years ago. On making an examination of the boilers I found them badly pitted and covered with a blister, as F. I. F. calls it, for a space several inches wide the whole length of the boilers, just at the water line. The blisters were almost entirely of rust, under which, when removed, the pits were from 1/16 to ⅛ in. deep.

I found that the trouble was caused by a homemade compound composed of a strong decoction of red oak bark boiled down in a barrel with a steam jet. My predecessor was a large man and was unable to go in the boilers and they were not insured, therefore nobody seemed to have inspected them for some time before I took charge.

My remedy was, of course, to stop the red oak decoction at once. Then I went over each boiler as I got the opportunity and scaled all rust out of the pits carefully, and coated the shell with boiled linseed oil. The only scale remover I used was kerosene. When I laid off a boiler to clean it, I allowed it to cool sufficiently to remove the top manhole plate, put in three or four gal. of kerosene and opened the blowoff valve slightly so as to let the water out slowly. Kerosene would stick to every part of the boiler and it loosened up all scale. In a short time the boilers were in very good condition.

E. R. RIVERS.

What Caused the Cake?

L. F.'S PROBLEM on page 1131, Dec. 15 issue, could be analyzed as follows: The boilers being operated for 16 hr. out of each day up to a peak load would necessarily mean that the furnace temperatures were high. Blowing them down regularly, and not washing them out at least once a month where water conditions are not as good as they should be, may have left a certain amount of sediment in the bottom of the drum, which gradually caked itself into a thick slab. The last time that the boiler was under heavy fire the circulation of the water in the drum may have caused this slab to change its location before the boiler was blown down.

H. W. ROSE.

Allowable Turbine Bearing Temperature

WITH REFERENCE to the question of J. H. McK., appearing on page 1033 of the Nov. 15 issue, I would suggest the use of cyinder oil to keep down the temperature of his turbine bearings. The oil now used should be removed, the bearing well cleaned out and the cylinder oil applied for about 2 to 3 hr. I have employed this scheme with satisfactory results and as soon as the cylinder oil was put on, the temperature dropped very rapidly. F. A. LEKAVA.

PRELIMINARY arrangements for investigation of wages and prices in bituminous coal industry, as provided in coal strike settlement, of Commission appointed by President Wilson, were made at the first meeting, Dec. 29, held in cabinet room of executive offices. Headquarters have been established at Department of Labor building.

POWER PLANT ENGINEERING

Trade-mark, Reg. U. S. Pat. Office
(Established over 24 years.) Formerly PRACTICAL ENGINEER
PUBLISHED THE FIRST AND FIFTEENTH OF EACH MONTH
$1.50 A YEAR; 10 CENTS A COPY

BY THE TECHNICAL PUBLISHING CO.
537 South Dearborn Street, Chicago
New York Office, 150 Nassau St.

Notify us at once of any change of address, giving the old and the new address, so that your paper may always reach you promptly.

Copyright, 1920, by Technical Publishing Co.

Entered as second class matter May 1, 1908, at the Post Office at Chicago, Illinois, under the act of March 3, 1879.

Member, Associated Business Papers.
Member, Audit Bureau of Circulations.

Circulation of this issue 24,100

CONTENTS

The Handling of Cocoanut Oil. By Charles W. Geiger. Illustrated 121

Efficient Organization of Power Plant Help—I. By H. A. Wilcox 126

Deflection of Steam Pipes. By H. M. Brayton. Illustrated 128

Bion J. Arnold. By Walter Painter. Illustrated....130

Reading Chimney Losses Direct from CO_2 Charts. By Charles C. Phelps. Illustrated....133

A New Year's Message. Windmills in Parallel. Big Service in Small Packages....136

A Study of Dynamo Electric Machinery—X. By Ottomar H. Henschel. Illustrated....137

Hydroelectric Power Collection. By Charles P. Steinmetz 139

A Big Job in Little Time. By E. C. Hazier. Illustrated..141

The Failure of Condenser Tubes. Illustrated....142

The Seewer Pelton Wheel Regulator. By J. H. Blakey. Illustrated 145

Experiences at the Glendale Plant. By G. H. Kimball. Illustrated 146

Back Pressure on Compression Systems. By A. G. Solomon 147

Cranes. By Chester C. Rausch....150

Letters Direct from the Plant: Strength of Manning Boiler Firebox. Review of Issue of Dec. 1. Folly of Overloading Electrical Machinery. Steam Pipe Expansion and Other Things. Use of Exhaust Steam. Review of Issue of Nov. 15, 1919. A Design for a 30-In. Manhole Cover. National Engineers' License Law. Illustrated 152

Questions and Answers: Steam Engine Indicator Diagrams. Exceptions to Examination Question Answers. Why the Short Stroke? Heating an Office by Electricity. Caring for Idle Boiler. What Causes the Knock? Indicator Card Criticism. Why the Stop in Flow? Boiler Pitting Difficulty. What Caused the Cake. Allowable Turbine Bearing Temperature. Illustrated 158

Editorial: Human Engineering. Interconnections an Engineering Privilege. Utilizing Those Small Streams. New Use for Calculating Charts....162

Storing Coal by Means of Conveyors. Illustrated....164

New Marine Lighting Outfit. Illustrated....165

Trade News 165

Human Engineering

To build up in any industry an organization, the individuals of which will work harmoniously one with another, to outline the work of individuals in such a way that each is contented and the duties do not conflict, to develop in each man in the organization the talent which will bring him the greatest success are problems in what might rightfully be called human engineering. The power plant is not without these problems and the plants in which these problems are solved most satisfactorily are, as a rule, the most efficient; for the human element is, after all, the most uncertain condition with which the power plant has to deal.

In the final analysis, human engineering is the practical application of psychology and sociology. Just as there are laws governing the physical structures of the earth, so are there laws governing the mental actions of men. The latter, however, are not so well established nor are they so infallible; nevertheless, most men act pretty much alike under the same conditions and these actions are classed as laws. It is the uncommon man, the man above or below the average, commonly known as "peculiar," who deviates from the average laws of psychology.

Again, these laws are somewhat "bent" by the environment and mental training of the individual. The man raised in rural or ranch districts has a slightly different "slant" in his reasoning and thinking from the city man; likewise the boy from the tenements and the one from the boulevards will conduct themselves differently. Men in different professions, though their degrees of education may be parallel and environment the same, will arrive at their conclusions through different paths of reasoning. So, it is said, each man has an individuality and the problem of every executive is to determine what the individuality of each man working under his supervision may be and deal with him accordingly.

Undoubtedly there will be in every large organization one or more men who do not fit in exactly with the rest of the organization; these individuals and their influence complicate the problem, for it is frequently extremely difficult to locate the source of trouble.

The chief engineer is the buffer between the owner and his subordinates; he must deal with all, iron out complaints on both sides, develop the ambitious individual to his place of greatest usefulness, choose proper men to fill vacancies, discharge the hopelessly inefficient or trouble maker, secure from the owner equipment or conveniences which will keep his men in the proper mental attitude toward their work. These are problems in human engineering and it is through their correct solution that we can hope to keep bolshevism out of the power plant.

Interconnection an Engineering Privilege

Interconnection of adjacent power plants is a potent force for good in the working life of the engineer. To some operating men, tying in with other stations may at first blush look like giving up altogether too much independence, and now and then the thought comes that loss of position may be the outcome of such co-operation. In reality, interconnection is doing more to broaden the outlook and deepen the professional skill of the alert

operator than almost any other factor which has made itself felt in power plant engineering during the past eighteen months.

In the past, the engineer has suffered greatly from insularity. Beyond occasional interchange of greetings and opinions at meetings of his organizations, he has been cut off from personal contact with the daily and hourly problems of his neighbors in far too many instances. The plant owner has failed to realize the value of frequent inter-station visits, and if it were not for the technical press, the visits of commercial men and the correspondence courses, not a few engineers would have settled into the life of technical hermits.

Now a better day has dawned. Interconnection has necessitated such thorough investigation of plant resources, loads, inter-station avenues of mutual approach, installation and operating costs, that engineers have perforce come together in business hours on their employers' time to discuss the economic situation involved in plant co-ordination. This has quickened their apprehension of possibilities outside the walls of their own installations, has brought them into contact with experienced electrical engineers with broad practice in many localities, and has aroused a new sense of co-operation.

It is undeniable, of course, that in a good many instances, interconnection has resulted in the shutting down of relatively inefficient stations and probably in changes in position which "came hard" for the time being to the men themselves; but the field of power production and distribution is after all so vast that it is doubtful if the demand for competent operating men can be met for many years to come, looking at the power industry as a whole. The inefficient stations cannot compete indefinitely with the more economical ones, when costs are against them on the ultimate analysis, and what self-respecting engineer cares to "hold down a job" which he knows has neither outlook nor justification for existence? Then, too, interconnection challenges every station involved to show its best efforts and mend its ways if they can be mended. By and large, it is a real privilege to the engineer to "get mixed up" with a big problem of this sort, and where the new requirements are faced rightly, with whole-hearted co-operation toward efficient co-ordination of plant resources, the engineer may well be glad of the opportunity thus to broaden his horizon.

Utilizing Those Small Streams

Following the publication of a Report of the Pacific Coast Section of the N. E. L. A. on Automatic Induction Generator Plants, we called to the attention of the readers of Power Plant Engineering in an editorial appearing on page 746 of the Aug. 15, 1919, issue the advantages to be derived by the employment of such power plants wherever it may be possible to install them. Since that time, the country has experienced what virtually amounted to a coal famine and although the difficulties existing between the mine laborers and the operators which precipitated that condition have apparently and happily been ironed out, a shortage still exists and what is of greater import, the price of coal is to advance. Thus we see a continued tendency for power costs not to recede, no not even to remain stable, but ever to increase. The effect of this upon the cost of living is obvious and calls forth no comment.

Fortunately properly directed activity can at least in part counteract this present state of affairs. We mean the development of our water powers and while waiting for our Congresses to enact the necessary legislation the providing for the utilization of navigable streams, much can be done toward not only assisting in overcoming the present shortage of power but also as a measure to conserve our available coal supply by the installation and operation of small induction generator plants on the many small water powers now going to waste. These may be used in conjunction with existing systems or where sufficient water is to be had at all seasons of the year these plants could without doubt be in many cases made to furnish light and power to small isolated communities within close proximity.

In some few instances, perhaps, the initial cost of installation of such plants might appear excessive; but prejudice should not be allowed to predominate, for while first costs may be great, the expense of operating such a plant, or even system of plants, is negligible, especially so when considering the fact that they may be made practically automatic in operation. The reduction of labor costs to a minimum is of itself of sufficient importance to warrant due, careful and thorough investigation.

New Uses for Calculating Charts

Power plant instruments as a rule indicate conditions or give quantities which are not the ultimate result desired but merely factors which, used in formulas together with other readings, enable the engineer to make comparisons that are of value in keeping the efficiency up to the highest point.

Frequently the formulas are so involved that considerable calculation, requiring reference to tables, is necessary before the solution can be obtained, and by the time the problem is solved the condition is something else so that an inefficient condition may exist for a considerable length of time, due to the fact that the person in charge does not have constantly before him figures showing present losses or efficiencies.

Readers of Power Plant Engineering are familiar with many charts designed to solve special formulas quickly, which to a great extent answer the need of the operator for instant information; but too frequently the charts are not available to the operator or he finds difficulty in using them. Power plant men will therefore welcome the information given on another page of this issue by Mr. Phelps for reading the furnace losses direct from the record of a CO_2 machine and a flue gas thermometer.

Unquestionably a calculating chart can be designed to be attached to the scales of many instruments which will give almost instant solution to problems which now are either never solved or the solution is made a whole day too late to be of most value to the plant.

This use of calculating charts is new and it is hoped that instrument manufacturers will avail themselves of this and other methods of giving direct results.

Yearly Index

THE INDEX for Volume XXIII of Power Plant Engineering is now prepared and will be sent free to subscribers upon request.

Storing Coal by Means of Conveyors

AN INTERESTING application of conveyors for storing coal is shown in Fig. 1, illustrating five machines being used to unload coal from hopper bottom cars direct to storage pile. Four of these machines are 12 in. wide by 24 ft. long, the other one being 12 in. by 20 ft. Each is equipped with its own electric motor and can be operated singly if desired.

to better advantage for general work about the plant.

A great advantage of using the conveyor to unload hopper bottom cars is the fact that no track hopper or pit is necessary. This makes it possible to unload cars at any point along the track. To unload a car, the scoop or feed end of the machine is placed near or under the car hopper. The hopper door is then released and the belt on the conveyor carries the material away as fast as it flows through the hopper opening.

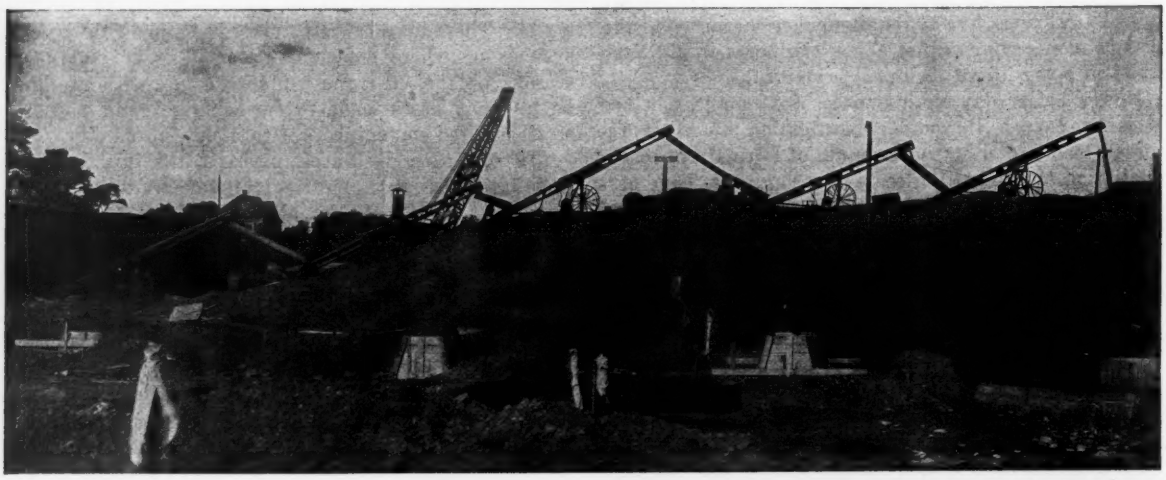


FIG. 1. UNLOADING COAL A DISTANCE OF 150 FT. WITH FIVE CONVEYORS

These machines provide a convenient, efficient and flexible arrangement. The first machine is practically self-feeding from the hopper doors of the car and the other four may be swung around at any angle to cover a wide storage area. Five machines arranged in this manner can be operated by one or two men. They can also be used to convey the coal direct from storage pile into boiler room. Figure 2 shows four machines being employed in this manner. Where desired, one machine

FIG. 2. USING FOUR CONVEYORS TO CARRY COAL FROM STORAGE PILE INTO BOILER ROOM

can be used to load an electric storage battery truck to convey the coal directly into the boiler room, as shown in Fig. 3.

The advantages of using several 20 or 24 ft. long conveyors are quite obvious. One long conveyor would not be as portable. It would be more difficult to adjust and handle and the shorter units can always be used

THE SWEET YOUNG THING was being shown around the power house and she espied a bucket of sand. Being very inquisitive of all that was shown her, she said:

"That is sand, so the bucket sign reads."

"Yes, ma'am."

"What do you use that for?"

"For fires in our armatures, or wiring."

"Why, I didn't know sand would burn!"

Just then the whistle blew and the fellow excused himself.

FIG. 3. LOADING COAL HOPPER ON A STORAGE BATTERY TRUCK WITH A CONVEYOR

The Sweet Young Thing is still wondering. I guess he is too. J. B. D.

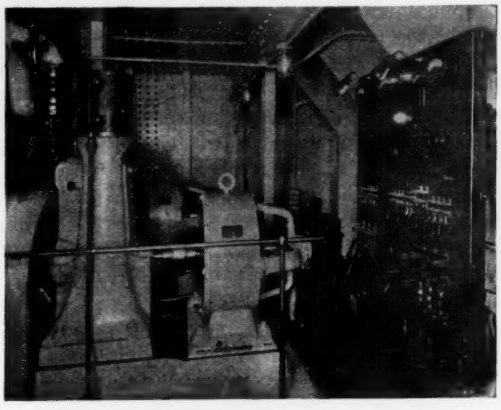
"IT'S EASY enough to make mistakes without assistance from others, but the 'breaks' sometimes make it look as if aid were not lacking."

A New Marine Lighting Outfit

A NEW line of engine-driven marine lighting generators, designed especially to insure reliability of operation, has recently been developed, ranging in size from 2 to 50 kw. Each consists of a steam engine coupled to a generator, the whole being mounted on a bed-plate, so as to form a compact unit. The 15-kw. size, shown in the illustration, is 6 ft. long, 3 ft. wide, 5 ft. high and weighs about 3300 lb.

The engine used in these sets is of the single cylinder, vertical enclosed V type, with automatic lubrication. It can be supplied for operation on steam pressures of from 80 to 250 lb. and is suitable for either condensing or noncondensing service. The engine speed ranges from 500 r.p.m. in the smallest sizes to 350 r.p.m. in the largest.

The generator, while in general of standard construction, is specially designed for marine service. The bearings are arranged so that perfect lubrication is assured, regardless of the tossing of the vessel. The windings are



TWO 15-KW. ENGINE-DRIVEN GENERATORS INSTALLED ON S. S. NEW BRITTON

specially insulated to protect them from salt and dampness. Metal parts subject to corrosion are made of non-corroding alloys. A special feature of these generators is their freedom from sparking at the commutator, even under heavy overloads. They are supplied for either 125 or 250 v. direct current, and for either two or three-wire systems.

Correction Note

ON PAGE 1005 of the November 15 issue an article entitled Unconsumed Fuel, and on page 1087 of the December 1 issue another entitled Measuring Producer Gas, by inadvertence were published without proper credit being given to The Power User of London, England. Likewise the article entitled Temperature in Diesel Cylinders, published on page 1091 of the December 1 issue, was used without credit to Shipbuilding and Shipping Record, an English publication. Apology is due these magazines and credit is given in the earliest possible issue after the discovery of the omissions was made.

"HE PROFITS most who serves best."

Trade News

H. W. JOHNS-MANVILLE CO. announces the removal, Jan. 2, of its Des Moines office to more modern quarters at 213 Ninth St. W. B. Roberts, Des Moines manager, says that the new location will give better facilities than ever for serving Iowa with asbestos and magnesia, electrical, automotive equipment and allied Johns-Manville products.

THE EXTENSION to the Belmont foundry of Link-Belt Co. at Indianapolis consists in completing two new furnace buildings and installing in one of them a 15-ton capacity furnace. The company is also purchasing the necessary machinery, such as rolling mills, sand blast and other foundry equipment needed to take care of the additional capacity. The building will be about 70 ft. wide by 400 ft. long. When finished, it will complete the foundry as originally laid out.

THE AMERICAN STEAM CONVEYOR CORPORATION, Chicago, announces that the Atlas Machinery & Supply Co. is now handling the sale of the American Steam Ash Conveyor in the company's St. Louis territory. This company has offices at 1416 Syndicate Trust Bldg., St. Louis, Mo., and is a new sales organization in that vicinity. It is headed by Wm. H. Patton, who recently returned to the United States after two years' service in the army, during which time he was in nine branches of the service, gaining experience of great practical value.

Associated with Mr. Patton is his brother, W. R. Patton, who for the past 20 yr. has traveled the central west, engaged in the sale of power plant equipment. During the past 4 yr. he has represented several of the large manufacturers as district manager. N. B. Stewart, who has been identified with the power plant machinery business at St. Louis for 25 yr., has also associated himself with this company. His acquaintance and experience will assist the organization to give real service to the trade.

THE ARROW ENGINEERING CO., of Chicago, will hereafter represent The National Pipe Bending Co., of New Haven.

HUGH L. SIEGEL, formerly general sales manager for the Ford Roofing Products Co., is now with Walter A. Zelnicker Supply Co., as assistant to the president.

THE SANDUSKY PACKLESS VALVE CO. has recently moved into its new factory which is equipped throughout with the most improved machinery for the manufacture of packless valves, for which the demand has outgrown former manufacturing facilities.

ANNOUNCEMENT has just been made by Pratt & Cady Co., Inc., of Hartford, Conn., of the appointment of E. Coit Magens as director of sales; O. Lamson Beach as manager of the Metropolitan Store, 259 Canal St., New York City; Quay T. Stewart as sales representative, Minneapolis, Minn.; Henry J. Bride as sales representative, Hartford, Conn.; also the opening of branch stores at 529-531 Arch St., Philadelphia, Pa., H. H. Freund, Jr., manager; 505 Mission St., San Francisco, Calif., C. R. Mendelson manager.

ON JANUARY FIRST, all of the sales and contracting business which has formerly been carried on by the General Fire Extinguisher Co. was taken over by Grinnell Co., Inc. This change was made because the old name so specifically described the automatic fire protection section of the company's business that it prevented any natural assumption on the part of the public that the company was engaged in several closely related lines of business. As a matter of fact, the company's business is based fundamentally on industrial piping.

EDWARD D. KILBURN, who, since March 15, 1917, has been New York district manager of the Westinghouse Electric & Mfg. Co., was recently elected vice-president and general manager of the Westinghouse Electric International Co. Mr. Kilburn was graduated from Cornell University, and immediately after leaving college entered the employ of the Westinghouse Electric & Mfg. Co., for a number of years being located at the Syracuse office of the company. Subsequently, he was transferred to the Westinghouse Machine Co., with headquarters at New Haven, Conn. In 1915 he returned to the Electric Co. as manager of the power division of the New York office. A year later he was also made manager of the railway and lighting divisions, subsequently becoming manager of the office.

ANNOUNCEMENT is made of the recent reorganization of the Ohio Blower Co. under the name of The Ohio Body & Blower Co. The new company has taken over the three plants of the old organization, two of which are located in Cleveland, and the other in Orrville, Ohio. The reorganization is accompanied by an increase in capitalization to three times that of the Ohio Blower Co., and an addition to the factory to provide space for the manufacture of motor bodies, a new addition to this company's list of products.

The Ohio Blower Co. was organized 18 yr. ago, its original products being the Swartwout cast iron exhaust head and a system of dust collections. From time to time additions have been made to the list of products, including steam and oil separators, steam traps, water-level control valves, rotary ventilators, and core ovens. During the war a standardized slip cowl was brought out by the company and used extensively by the government. The latest addition is the Lind motor body.

The officers of the old company, D. K. Swartwout, pres., and H. H. Lind, vice-pres, will assume the same offices in the new one.

THE 1920 CALENDAR of Ric-Wil Co., Cleveland, Ohio, was recently received.

THE LATEST ISSUE of the Contractor's Atlas, which is published monthly by The Atlas Portland Cement Co., of Chicago, and deals with contracting work, especially in the field of concrete construction, was lately received.

REVISED AND ENLARGED Bulletin No. 112-B entitled "Condensers, Pumps, Cooling Towers, Etc.," has just been published by the Wheeler Condenser & Engineering Co., Carteret, N. J. This bulletin illustrates the latest developments in condenser practice. It shows a surface condenser containing 50,000 sq. ft. of surface; 16 condensers of approximately this size are now under construction, which will contain approximately 1000 mi. of Crescent Brand tubing. The bulletin shows photographs of a number of actual installations of surface condensers. It illustrates and describes surface, jet, and barometric condensers, the Wheeler-Edwards air pump, the Wheeler rotative dry vacuum pump, the Wheeler turbo-air pump, the Wheeler steam jet air pump, centrifugal pumps for all services, natural and forced draft cooling towers, feed water heaters, and evaporators and dryers. This bulletin will be sent to responsible persons upon mentioning this publication.

WESTINGHOUSE UNDERFEED STOKER is the title of a 36-page, 8½ by 11-in. booklet, illustrated throughout, with an attractive three-color cover, just issued by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Under the head of Details of Construction it gives a comprehensive description of the leading features of design contributing to the efficiency and reliability of operation. The interconnection of grates and tuyeres and the arrangement of brackets, gears and fuel deflecting plates, are clearly described. Taking up the principles of operation the circular explains, by use of sectional cuts and charts, the distinctive features of the Westinghouse zone system of air distribution.

The subjects of Efficiency and Capacity are taken up, together with Flexibility. Curves setting forth extensive performance data relative to these subjects and others are used to amplify the text. Under the subjects of Coal-Saving Problem and Fuel Burning Equipment of Modern Power Stations, an interesting and instructive array of information is given for the benefit of those who have the operation of stokers in charge. A large list of representative installations making use of these stokers is another prominent feature.

A BOOKLET entitled "Securing Better Combustion of Midwest, Western and Southwestern Fuels" and issued by Green Engr. Co., East Chicago, Ind., is now available to directors of power plants and their engineers.

NEW TRUTHS AND OLD FALLACIES is the title of a booklet just issued by the Magnolia Metal Co. It contains intimate and instructive information concerning babbit metals which is not generally known and which has been gathered by scientists studying the problems continuously for years past. Users of bearing metals will doubtless find the booklet a helpful guide in selecting metals and may secure a copy by addressing the company.

NELSON VALVE catalog and price list No. 10, of 156 pages, on the company's gate, globe, check and non-return valves, in bronze, iron and steel, was recently received from Nelson Valve Co., of Philadelphia.

CHESTNUT RIDGE CORPORATION recently sent out a circular of its product superseding fire clay under the name of Pyrobond. This name was chosen from a number sent in competition. After a search made by a trade mark firm at the U. S. Patent Office, no similar name was disclosed, and an application was filed for registration. It now appears there is a concern which has been using a somewhat similar word, and whose business is not widely known. Under these circumstances the Chestnut Ridge Corporation has changed the name of its product to "C.R.C." (Chestnut Ridge Corporation) which name cannot well be infringed upon.